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REPORT

Preserving Range and Airspace Access for the Air Force Mission

Striving for a Strategic Vantage Point

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Prepared for the United States Air Force

RAND PROJECT AIR FORCE

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Preface

This report, its appendixes, and the accompanying compact disk document RAND Corporation research on the range and airspace training infrastructure for aircrews and the information and data range managers require to optimize use of and investment in Air Force ranges and assure continued access to those ranges not owned by the Air Force in the United States and overseas yet are critical to Air Force mission requirements. Our objectives were to describe the changing management environment, identify the related challenges and the information required to address them, and provide an example of a relational database to facilitate a robust understanding of the demands aircrew training makes on ranges and airspace.

The technical data and details outlined in the appendixes focus on activities to collect, review, and update Air Force operational flight training data sets first provided in a relational database that RAND and Air Combat Command (ACC) developed several years ago. We expanded the data sets to include training programs that Air Force Special Operations Command (AFSOC), Air Education and Training Command (AETC), and Air Mobility Command (AMC) administer. The compact disk supplies the updated decision tool. The data sets establish standard maneuver parameters for training activity that can be used by units in building training sorties and by range managers and other program managers in understanding the training demand on test and training ranges and special-use airspace in the United States and overseas.

This report is intended to inform strategic planners, programmers, operational training managers and instructors, and users of air and space training infrastructure capabilities. Because the research discusses the relationship between combatant commanders' warfighting requirements and the range and airspace infrastructure needed to supply them, it should be of interest to Air Force operators, those who employ air and space forces, and anyone involved with developing or training air and space crews, including those in the air reserve component. It will also be of interest to those in the Department of the Air Force who must advocate for and defend range and airspace access before public and private entities.

This is one in a series of RAND reports that addresses improving the Air Force's ability to connect operational requirements to advanced training and its supporting infrastructure by making these relationships more explicit. Related publications include

- *Relating Ranges and Airspace to Air Combat Command Missions and Training*, by Albert A. Robbert, Manuel Carrillo, Robert Kerchner, Willard Naslund, and William A. Williams (MR-1286-AF)
- *A Decision Support System for Evaluating Ranges and Airspace*, by Albert A. Robbert, Manuel Carrillo, Robert Kerchner, and William A. Williams (MR-1286/1-AF)

- *Absorbing and Developing Qualified Fighter Pilots: The Role of the Advanced Simulator*, by Richard S. Marken, William W. Taylor, John A. Ausink, Lawrence M. Hanser, Clarence R. Anderegg, and Leslie Wickman (MG-597-AF)
- *The Thin Green Line: An Assessment of DoD's Readiness and Environmental Protection Initiative to Buffer Installation Encroachment*, by Beth E. Lachman, Anny Wong, and Susan A. Resetar (MG-612-OSD)
- *Investment Strategies for Improving Fifth-Generation Fighter Training*, by John A. Ausink, William W. Taylor, James H. Bigelow, and Kevin Brancato (TR-871-AF).

The Air Force Director of Air, Space and Information Operations, Plans and Requirements (AF/A3/5) sponsored this research, which was conducted in the Manpower, Personnel, and Training Program of RAND Project AIR FORCE as part of a project entitled "Preserving Range and Airspace Access in the Federal Aviation Administration (FAA) Free Flight Environment." The research for this report was conducted from October 2007 through October 2009.

RAND Project AIR FORCE

RAND Project AIR FORCE (PAF), a division of the RAND Corporation, is the U.S. Air Force's federally funded research and development center for studies and analyses. PAF provides the Air Force with independent analyses of policy alternatives affecting the development, employment, combat readiness, and support of current and future aerospace forces. Research is conducted in four programs: Force Modernization and Employment; Manpower, Personnel, and Training; Resource Management; and Strategy and Doctrine.

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Summary

The Air Force relies on access to flight ranges and their associated airspace for a variety of critical training and testing activities. Specific range activities include test and evaluation of new weapon systems and aircraft; formal training, which enables aircrews to receive foundational instruction and hands-on experience; and continuation training, which refines the skills necessary to achieve levels of combat capability needed for overseas contingency deployments and a range of warfighting challenges.

In upholding access rights, range managers and other stakeholders (including the Air Force and FAA) need to know what the requirements are for an activity and how it relates to joint missions and national security objectives. This key information becomes more critical to smooth test and training flight operations as various range managers and mission stakeholders (such as the military liaison at the FAA) set priorities among multiple military and civilian users for specific areas. Making these requirements more visible during planning, scheduling, and long-term resource decisionmaking processes will, in turn, help maintain access by enabling managers at all levels to make decisions that are more precise and effective. Developing a full understanding of the *intended* use of range infrastructure by creating a common body of knowledge about prior and planned unit activities would improve the analytical basis for test, training, and operational decisions. Better use of this knowledge should help adapt range infrastructures to meet an objective requirement instead of forcing units to adapt to range capabilities.[1]

Even as the FAA is overhauling the National Airspace System, working to make airspace allocation more dynamic and agile, communities and commercial concerns continue to spread into land previously considered remote, further complicating the access problem. The Air Force must be able to determine its actual requirements confidently and to convey its confidence to other stakeholders. Positive results will also require incentives for such landowners as the Bureau of Land Management, the U.S. Forest Service, and surrounding communities to encourage them to preserve the qualities Air Force units value, thus keeping the areas suitable and available for future access. In the midst of this, however, the main objective should be precise and efficient range use. Achieving this is partly about management strategies stressing efficiency, for which range access is the desired outcome. But this quest for efficiency must be tempered by well-informed decisionmaking.

The FAA's approach to airspace allocation is becoming more dynamic and more agile, making a full complement of information about the desired outcomes of test and training

[1] The approach referred to here requires not just having a common data structure for the information about requirements but also structuring how users and managers interact and the timing.

activities essential. A decision space incorporating that information will also help the Air Force link range activities to selected joint missions and national security priorities. The paramount objectives must be both making efficient use of ranges and being able to demonstrate prudent and fiscally responsible management of the range resource.

Background: The Need to Improve Range Management Capabilities

In recent years, Air Force demand for range assets has grown and changed dramatically. The ongoing wars in Iraq and Afghanistan have increased the demand for specialized training, often scheduled on short notice. At the same time, resource constraints in the defense budget and the threat of civilian encroachment have complicated the range management.

These changes present challenges to prudent and effective range leadership. Over the long term, these challenges will require an investment strategy for ranges that (1) provides sufficient lead time to support evolving training and testing needs, (2) meets the need to explicitly connect that investment strategy to joint mission and national security requirements, and (3) supports an approach to sustaining desired range capabilities. The present difference in perspective may be magnified by the lack of a common framework for making decisions about range use and resource allocation.

This situation requires managers at all levels to possess a depth of information about range demands, usage, and user expectations that does not currently exist. Range management processes and the supporting information infrastructure have not kept pace with evolving training demands. Range management has essentially not changed since the ranges were created after World War II. The local, wing-level range manager has the primary responsibility for decisions about range configuration, operating tempo, and investment needs but often lacks information about the training needs of users, especially those based elsewhere. In this environment, decisionmakers and managers often cannot obtain detailed information on training requirements from range users.

Currently, training requirements flow to the range community from external sources, generally the major commands (MAJCOMs). From the range's viewpoint, knowledge about these training requirements is created when a unit schedules range use and adjusts its expectations to the areas to which it has actually gained access. However, the bulk of unit expectations are not explicit or captured for archiving. At this stage, the "requirement" merely expresses the need for access to a reasonably sized and equipped range area.[2] Even when the unit itself operates the area in question, knowledge is rarely all inclusive at this point. This lack of information makes prudent operations and investment decisions very difficult.[3]

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[2] Range area, used in this sense, could be a maneuver area, a low-level training route, an air refueling track, or even an air mobility drop zone.

[3] Our research found that many units with low range priorities scheduled large areas, then used local procedures or agreements with range managers to reconfigure the airspace to meet their needs, sometimes subdividing the area into smaller areas or the time available for multiple flights. While there is nothing technically wrong with this practice, the apparent demand masks the actual use from the range manager. Over time, this interferes with the manager's ability to develop range structures and capabilities that better meet the unit's actual requirements. The unit is merely adapting its activities to the resources it can secure. Discussions with 46 Test Wing, 98 Range Wing, 1 Special Operations Wing, and USAF Weapons School personnel, November 2007–July 2009.

It is also becoming imperative for the service to justify its range use more deliberately. Ranges are under pressure not just because of scarce funding but also because external entities are seeking greater access to the land and airspace the ranges occupy. These pressures can constrain the types of activities conducted at the range or lead to the return of associated land and airspace to other uses, such as more-direct routing of commercial airline traffic.

Objectives and Methods

To address these issues, RAND Project Air Force identified and developed information Air Force managers need to manage and utilize ranges and airspace more effectively and efficiently. In particular, the RAND team updated the Air Force's understanding of the evolving environment for ranges and special-use airspace. This included the changing demand on ranges (both Air Force and other range providers), resource constraints, and other factors identified in a review of the management challenges growing out of this evolving environment. We paid particular attention to the information and data required to address these challenges. We then reviewed processes and developed a strategy for incorporating needed information and data into a common relational database for Air Force ranges.[4]

For this research, we gathered quantitative and qualitative information about how ranges are being used in test and training activities from ACC, AMC, AFSOC, and AETC training documentation, program managers, the USAF Weapons School instructors, and other selected units. We also updated an existing RAND Decision Support Tool and populated it with data on tactics training.

The Air Force's Center Scheduling Enterprise (CSE) is a web-based scheduling program and relational database. RAND's decision support tool is intended to be part of a broader information system that would improve daily scheduling transactions on range complexes and support improved range management decisions and enterprise investment. In 2001, we created a relational database with range requirements and related information that uses an illustrative interface for managers' queries. We further pointed out the necessity of a web-based system to organize information on range capabilities, capacity, and use. The Air Force is using such an approach for CSE, creating a broader information system that can feed into such analytic tools as RAND's, which require it for currency and proper operation.

Working partly with information from this broader environment, the RAND Decision Tool and other analytic tools could then use archived data from the CSE program about range use to support range management decisions and defend the need for continued access to ranges and airspace. Thus, the tool requires a broader information-gathering system for collecting, organizing, and archiving data about ranges and range use. While portions of the RAND tool were updated and expanded, it is not yet completely integrated with the broader information system it requires to remain current. There is also no process for regularly updating information developed specifically for the RAND tool. RAND put a great deal of effort into updating

[4] In parallel with the research effort and with initial funding from the U.S. Joint Forces Command, the Air Force began development of a relational database program to use for range and airspace scheduling. To work better with the training community, the program needed information and data sets RAND initially developed for Air Combat Command (ACC) in 2001. The intention was in better integrate both the scheduling program and the RAND databases. However, this was not possible due to Air Force priority in fielding the scheduling program during the research period.

range training requirements and organizing them into a series of training categories. These are authoritative tactic-based mission profiles that can help schedulers and program managers plan range use. Training program managers need to integrate these requirements into their program requirements. Doing so will allow integration of the mission profiles into enterprise scheduling programs for decisionmaker analysis or for units using CSE for long-range planning. Range managers could also use these objective mission profiles to help improve range organization for the future. Other analytic tools could use this information and the broader information environment CSE provides, once it has been implemented across the range community.

Today's Changing Range Environment

In recent years, range demand and usage have undergone dynamic changes. There have been four primary drivers of these changes:

- **Changes in training needs.** Since September 11, 2001, Air Force units have sought combat-focused, shorter-notice continuation training. Along with this change has come a desire for tactically robust ranges to expose units to realistic environments prior to deployment. More training has focused on meeting rising deployment tasks within the unit's broad desired operations capability. Unit commanders have gained more authority to shape their training activities, working within guidance from training program managers (Air Force instruction and supplements and tasking messages) and fiscal constraints (e.g., annual and quarterly flying hour allocations).
- **Resource constraints.** As defense spending tightens, budget constraints are affecting the acquisition of new range systems and sustainment of existing range capabilities. These constraints will require range operations to become more cost-efficient while maintaining sufficient capabilities. Contingency funds for range operations may decline as deployment operations wind down and/or be more normalized within the range program.
- **Encroachment**. Civilian populations near ranges limit how the facilities can be used. A number of factors cause encroachment pressures: growing civilian populations in close proximity to ranges, energy development programs that seek to install wind turbines on land now set aside for Air Force use, and the increasing demand for airspace to accommodate the growth in civilian air traffic.
- **Next-Generation Air Transportation System (NextGen)**. The impending implementation of a Global Positioning System satellite-based tracking and routing system for all aircraft—NextGen—will complicate the management of ranges and airspace and increase the urgency of modernizing the information infrastructure to support planning and management decisions. This system gives controllers the ability to shift air traffic dynamically, as air traffic problems develop, possibly moving the traffic over geographically fixed range infrastructures. Air traffic flow decisions will come more from a national vantage point and less from that of local terminal or regional center. Regional and local military liaisons will remain valuable, but mitigating the effects of dynamic traffic reconstruction may require a national military authority working with peer organizations (major airlines) and FAA national entities. Understanding priorities and the context for military activity will be more important in the NextGen era.

Management Challenges and Information Needs

These changes pose significant challenges for range management. The main challenges include

- clarifying the understanding of training requirements and developing flexibility in the response to continuation-training needs
- creating realistic range environments according to objective test and training expected outcomes
- understanding competing priorities for range and airspace allocation.

A common data approach across ranges would help the Air Force address these challenges. A common approach would help units find training opportunities, range managers understand range use and posture them to anticipate range demand, and program managers and higher command levels make informed decisions about improving and advocating for range capability and capacity. Units have a finite time to train to meet deployment tasking but can enhance their use of this time with the help of a common information strategy that helps managers understand both the immediate requirement and its broader context. The approach does not require a common control or ownership; it focuses on creating an environment in which users can better communicate their needs, making the system more timely and richer in actionable information for managers. This approach must enlist training program managers and, ultimately, the weapons and tactics officers who create and sustain the techniques, tactics, and procedures that become the test and training template.

A range and airspace automated scheduling program could support a common data approach in the range community. Such a program could contain a catalog of range capabilities, which would allow range users to communicate range requests. CSE is an example of this type of program, one with broader information implications. The program could also give range managers access to historical scheduling information and could help them structure the scheduling dialog to work with users. Finally, the program could also inform program managers though the reports it produces. By integrating that information with other data and decision tools, managers and other range and airspace decisionmakers could examine how efficiently and effectively the range is meeting training needs and could also explore future range use. The use of a centralized scheduling program will create a unified information structure, which analytic tools require.

To provide an example of such an analytic tool, we updated an information tool—the RAND Decision Support Tool—that RAND had previously developed as part of a system to help the Air Force improve decisionmaking about ranges and airspace.[5] This tool would improve managers' access to the information needed to respond to scheduling and utilization challenges. For that to happen, a CSE report would need to be configured to provide the needed data sets. Likewise, data sets from the RAND tool would be modified and incorporated into CSE. Since CSE is a relational database, it should be useful to report data for a wide range of decision tools. See Appendix B for more details about this tool.

[5] Robbert et al., 2001b.

Implications for the Air Force

An implication running through all these challenges is the need for enhanced information practices and a higher-level perspective on range demand and usage than the current, local information-infrastructure affords. Units are interested in a wider, regional set of realistic or more-specific range experiences (e.g., close air support working with a ground element) and in scheduling tactical sorties, when the range complex will support them. These challenges require managers at all levels to possess a greater depth of information about range demand, usage, and user expectations than they currently have.[6] Our analysis suggests four general implications for how the Air Force can respond to these challenges:

- **Specify required training resources.** Statements of range and airspace requirements need to be more specific, more comprehensive, and more timely than they are at present. Under the current model, some ranges are underutilized, even as some units need additional range training opportunities. In addition, range complexes become reactive when managers lack timely and accurate information to posture range contracts and personnel and make prudent investment decisions. With a broader view of and more timely information on training needs, program managers can ensure that decisions about MAJCOM operations, range maintenance funding, and range operations contracts properly anticipate surges in range operating tempo. This strategy can balance local range capabilities against off-station training opportunities, thus minimizing range operating costs and providing units with operational flexibility to meet training requirements. An optimal strategy requires the ability to collapse planning time lines and even support modeling different operations approaches with their effect on capacity.
- **Collect range usage data.** Range managers and users alike would benefit from detailed data collected from completed training activities. To make this possible, unit flying scheduling programs need to be able to feed mission information into the range data archive for each sortie, comparing the mission profile scheduled with the mission profile flown. Storing data in a relational database could also help the system respond to FAA's anticipated requirements for computer-to-computer reporting. Recording actual use rather than scheduled use will facilitate range management because it allows managers to make decisions based on real data instead of forecasts or extrapolated information. This means that environmental management tasks can be planned when actually necessary instead of when they are forecast to be necessary based on scheduled use. Greater information precision keeps areas active and expends funds only when necessary to remain within environmental regulations.
- **Define range expectations more clearly.** In response to external pressures, the Air Force must be more deliberate in justifying its range use. Toward that end, range managers need complete information about the intent of range activities. Using mission profiles linked to joint mission objectives would help satisfy that need. The information does not need to be detailed but does need to be correct to build public confidence and trust.

[6] User expectations are important to know because this research found units adapting their activities to the range infrastructure available to them. For example, we found units reserving large maneuver areas and dividing them into smaller areas for the use of separate groups. Units would develop local procedures for maintaining separation within the larger area. If range managers understood this need, they would have the opportunity to structure the area to facilitate this type of use, perhaps freeing a portion of the area for other users.

Much of the range complex infrastructure uses public lands. The Air Force also leverages the range capabilities of other services and foreign hosts. Better defining test and training expectations helps to establish the high priority of range activities. When events occur that affect range activities, managers at all levels are better equipped to respond in ways that preserve expected outcomes.

- **Provide range information that goes beyond the local level.** Users and managers alike would benefit from a regional or national perspective on range availability and demand. Units are seeking training opportunities well beyond their historic local range community. Managing range resources needs this broader perspective too. In addition, this higher vantage point can help the Air Force prepare for the transition to NextGen, which will require the Air Force to make more timely range operations data available to FAA monitoring systems. Units are seeking range capacity on a regional and even national level to meet deployment taskings and conduct mission rehearsals in near combat conditions. Even local resources will have multiple users beyond the operating wing or group. This requires a higher vantage point from which to make informed decisions about range investments and priorities and even to manage contracts affecting the daily range operating tempo.

Recommendations for Possible Air Force Responses to These Challenges

To act on these implications, the Air Force needs to improve the data it generates and collects on range and airspace usage and to develop a strategy for incorporating the data into a common enterprise system for Air Force ranges. A key part of this is a more-unified approach to training—especially continuation training. Possible specific responses could include

- **Developing training templates for use in scheduling.** Units that schedule training can help range managers understand their training needs by using tactically based mission templates that capture the basic requirements of various training sorties. The templates would originate with MAJCOM-level tactics officers, instructors, and training program managers. This information could include the airspace and range capabilities required to meet the training objectives and any additional requirements, such as a radar threat, coordination with a tactical ground element, or aircraft sensors that work with other aircraft in close air support.
- **Making an automated scheduling tool the standard format for range training archives.** Information on completed training activities can be stored in the scheduling tool's database, which will furnish Air Force managers and decisionmakers with detailed information on how ranges are actually being used.
- **Using an automated scheduling tool to influence the range "market."** The range community can use the tool's information structure to encourage adoption of data standards as a condition of range use. The ability of such a system to share data with other decision tools will benefit decisionmakers at all levels. It will also benefit users because they will encounter a common transaction process to secure range access. A market will form as providers inside and outside the Air Force adopt the automated system. Scheduling can be rolled up for smaller range complexes without owners losing control over their range complexes. With a fully functioning common market for range access, it would

not be necessary to own or operate every range complex. Managers would use the market structure to allow a wider set of users to participate. Rules governing unit priority in the retail transaction would provide a means for local managers and MAJCOMs to focus range capability as they believe necessary.

- **Using the tool at higher levels.** In addition, a scheduling tool can be networked so that it can share information with program managers and other decisionmakers about how well range use is meeting training needs. The program can create reports that provide information about individual complexes and can document usage across the entire enterprise. Armed with better information, range managers can become more effective advocates for ranges. They can also be better prepared to evaluate alternative use proposals and the potential consequences for range operations. The enterprise vantage point, once established, can help inform local decisions. Transferring ownership is not necessary to improve the effectiveness of operations. The range market that emerges helps inform managers at all levels.
- **Preparing data that are compatible with FAA's planned NextGen system.** The Air Force must also establish an operational-level counterpart to work with the FAA as the NextGen system is implemented. This counterpart must have the military enterprise authority necessary to successfully interact with NextGen-era planning and controlling entities to preserve access when NAS operations shift geographically or temporally. As NextGen systems are fully implemented, the FAA's new ability to view special-use airspace status and act on what it sees will pressure the Air Force to open military test and training areas to commercial air traffic. As NextGen is fielded, some of these tasks may be automated. The FAA expects that data on military's use of ranges and airspace will be transmitted using the same new GPS-based machine-to-machine reporting system that commercial air traffic will use. The vantage point needed is one that encompasses all MAJCOMs with flying units. The Air Force should explore ways for this to happen using the CSE capability to automatically feed special-use airspace scheduling into the FAA flight planning and en route systems.

Concluding Observation

The challenges of range management arise from the need for better information about range demand, supply, and usage and the need for a standardized infrastructure for sharing that information across the range community, users, and other stakeholders. We see implementation of an automated scheduling tool as key to the Air Force's efforts to address these challenges.

It is possible that, through the common web-based enterprise scheduling program and analytic tools it supports, a national market for range capabilities may emerge as range providers opt into that program. It is possible that access to a regional or national network of range capabilities will become more useful than a local standalone range complex. What is evident is that, under such a market approach, units and MAJCOMs that participate and provide more information about their test and training requirements will lead the evolution of ranges even under the present system. Timely information provided in a context of intentions and purpose will help managers act precisely and advocate for their users. Range development could better incorporate operational needs if unit planning were more timely and complete. Local leadership from assertive and well-prepared units could have more influence than today not just on

long-range planning but also on the range operating tempo as managers gain more confidence in meeting unit expectations within management time lines.

With more information being shared with the range management community, units may also benefit from participating in an enterprise scheduling transaction. They can now better gauge the opportunity to train using regional and national resources when their demand exceeds local capacity. This is more likely to occur with compressed deployment time frames or when live ordinance training needs exceed the capabilities of the local range. The market approach may help encourage a better balancing of global management, using this vantage point to improve trade-offs and force structure planning. Units with local ranges having special capabilities would benefit from higher utilization and justification for further improvement. Use can be better balanced to support operational surges and periods where the unit may be reconstituting its force structure. Improving the information infrastructure that supports range management should help Air Force units better communicate their demand, thus helping range management become more effective and efficient.

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[1] The ranks and positions mentioned in these acknowledgments were accurate as of the time of our research and may have changed since.

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The authors appreciate the attention to detail and insight gained from detailed reviews by John Ausink and Willard Naslund.

Abbreviations

A3/5	Air Force Director of Air, Space and Information Operations, Plans and Requirements
ACC/A3T	ACC Flight Operations and Training
ACC	Air Combat Command
ACM	air combat maneuver
ACT	air combat tactics
AEF	Air and Space Expeditionary Force
AETC	Air Education and Training Command
AFB	Air Force base
AFI	Air Force instruction
AFMC	Air Force Materiel Command
AFRC	Air Force Reserve Command
AFSOC	Air Force Special Operations Command
AFSPC	Air Force Space Command
AGL	above ground level
AHC	advanced handling characteristics
AMC	Air Mobility Command
ANG	Air National Guard
ATM	air traffic management
ATCSCC	Air Traffic Control System Command Center
BFM	basic fighter maneuver
BSA	basic surface attack
C3ISR	command, control, communications, intelligence, surveillance, and reconnaissance

CAF	combat air forces
CAS	close air support
CCDR	combatant commander
CSE	Center Scheduling Enterprise
DOC	designed operational capability
DoD	Department of Defense
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
GPS	Global Positioning System
ISR	intelligence, surveillance, and reconnaissance
JAWSS	Joint Advanced Weapons Scoring System
LFE	large-force exercise
LSTSS	Large-Scale Target-Sensor Scoring system
LVC	live, virtual, and constructive
MAJCOM	major command
MOA	military operating area
MDS	mission design series
NAF	numbered air force
NAS	National Airspace System
NATO	North Atlantic Treaty Organization
NextGen	Next-Generation Air Transportation System
OCA	offensive counter air
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OPTEMPO	operating tempo
OSD	Office of the Secretary of Defense
PACAF	Pacific Air Forces
PAF	Project AIR FORCE
POL	petroleum, oil, and lubricants
RAP	Ready Aircrew Program

SAM	surface-to-air missile
SAT	surface attack tactic
SUA	special use airspace
TI	tactical intercept
TTP	tactics, techniques, and procedures
UAS	unmanned aircraft system
USAFE	U.S. Air Forces in Europe
WISS	Weapon Impact Scoring System

CHAPTER ONE

Introduction

Background

Flight ranges and associated airspace enable the Air Force to develop and test new aircraft and weapon systems, evaluate tactics, and train aircrews and supporting personnel. Air Force range and airspace activities include

- test and evaluation, which are essential for developing, producing, and fielding effective new weapon systems and aircraft
- formal training, which provides aircrews foundational instruction and hands-on experience
- continuation training, which is essential for aircrews to sustain and refine the skills to achieve combat capabilities for overseas contingency deployments and to adapt to emerging warfighting challenges.

In recent years, the demand for range and airspace assets has grown and changed dramatically:

- Increased warfighting demands since 9/11 are driving a greater need for short-notice training activities and more-realistic range environments. These training needs typically have national scope, potentially confronting local range managers with new units and training mission demands.
- New systems, such as F-22 and F-35 fighters, unmanned aircraft systems (UASs), and remotely piloted aircraft (RPA), are redefining how range airspace is used.
- Resource constraints are demanding that range investment, configuration, and management be more precise and efficient. These constraints also affect the number of flying hours available to units.
- The impending implementation of a Global Positioning System (GPS) satellite-based tracking and routing system for all aircraft—the Next-Generation Air Transportation System (NextGen)—will complicate range and airspace management and increase the urgency of modernizing the information infrastructure that supports planning and management decisions. This change from a radar-based air traffic management (ATM) approach to reporting positions using GPS-aided equipment makes military use more visible to pilots and controllers and influences flight planning and en route navigation.
- Encroachment increasingly threatens ranges. Sources of encroachment include population growth, energy development, and projected increases in commercial and private airline traffic.

As these changes have unfolded, range management and the information infrastructure that supports it have not kept pace. Range management has remained essentially unchanged since ranges were created following the World War II: A local, wing-level manager makes decisions about operating tempo (OPTEMPO) and investments. Yet the range manager often lacks information about training needs of users based outside the range. For these reasons, program managers at Air Force major commands (MAJCOMs), as well as wing-level range managers, have insufficient information about evolving range demands or the content of training missions flown in the airspaces they manage, limiting their ability to adapt to changing circumstances or make informed decisions for Air Force training and test and evaluation missions.

A lack of common information across ranges that would help managers understand the total demand in a national context also hampers range management. The information that does exist typically focuses on unit scheduling of separate range elements, and only limited data from the disparate transactions are available for tracking and analyzing actual range use.[1] When data are available, their content and structure vary from range to range and MAJCOM to MAJCOM. Because of poor information, range operations are shaped more by availability of contingency funding or competition for MAJCOM operations and maintenance funds than by actual need. In addition, range requirements are rarely explicit enough to forecast changes. They should be stated in a way that allows managers and planners to make trade-offs and better configure range complexes for the future. The problem is more acute for combat units whose range use is primarily for continuation training. Units know their designed operational capability (DOC), and MAJCOM training requirements, but an actual operational deployment tasking may significantly change the character of their training sorties that precede the deployment. It may be that certain DOC tasks have higher priority and require more attention to achieve the DOC for this specific deployment. Contingency funding has helped to mitigate the impact of this for range complexes, but this funding source will soon decline.

Like the fiscal environment, the ATM environment is changing both here in the U.S. and overseas (e.g., the European Organisation for the Safety of Air Navigation [EUROCONTROL]). These changes may call for balancing test and training among live flight and other means, such as simulators. In the NextGen era of ATM, military training activities may become more visible and therefore more subject to demands from other air traffic for airspace. It will be critical for training program managers to link their requirements to joint missions and national security objectives as a way to set priorities for range and airspace use. NextGen also changes how pilots and controllers use information about military special use airspace (SUA). The dynamic expectations for how the future National Airspace System (NAS) will operate will require the Air Force to resolve ATM airspace conflicts as events unfold in the NAS.

[1] One unit scheduler stated that schedules on an Excel spreadsheet were printed and filed in a desk drawer. Staff would mark up this copy in red to account for changes during the flying week. While this worked for the unit, it produced information that neither helped complete the annual flying plan nor was available to range managers for further analysis.

Study Objectives and Analytic Approach

The Director of Current Operations at Headquarters Air Force asked RAND Project AIR FORCE (PAF) to recommend approaches for Air Force managers at all levels to obtain better information for managing and using ranges and airspace more effectively and efficiently. In response, we

- examined the evolving environment for ranges and SUA, including changing demands, resource constraints, and other factors
- identified the management challenges growing from this evolving environment and the information and data required to address them
- drew implications for Air Force responses to these challenges and identified possible actions to address the challenges.

To address these tasks, we gathered quantitative and qualitative information about how ranges are being used for testing and training. We also updated earlier RAND work on a decision support tool by expanding from its focus on training for Air Combat Command (ACC) to include information on training for Air Mobility Command (AMC), Air Force Special Operations Command (AFSOC), and Air Education and Training Command (AETC) units (Robbert et al., 2001a; Robbert et al., 2001b). In addition, we updated the ACC data sets in the RAND Decision Support Tool and produced a tactics-based objective data set for quantifying the training requirement that drives range and airspace use.[2]

In a parallel effort, we began a continuous dialog with the 46th Test Wing at Eglin Air Force Base (AFB) to help improve a web-based scheduling program that the 46th Test Wing is developing for the Eglin AFB range managers and local test units.[3] This scheduling program was based in part on RAND's 2001 research recommendations that called for using web-based information strategies to help manage ranges. The program contained a listing of Eglin Range's capabilities, a process for units to request range access, and an archive of unit activities.[4] (The web-based program the wing developed is currently being expanded to include other ranges used by Air Force and Navy units as funding becomes available.)

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[2] Tactics-based objective data refers to the information needed to relate aircraft maneuver and procedures directly to specific tactics that combat tasks require. Appendix B discusses the decision tool. Appendix C lists the Joint Mission Framework, which is an integral part of the tool. In addition, the tool accompanies this report in CD form.

[3] Chapter Four describes this system, the Center Scheduling Enterprise (CSE).

[4] During this current research effort, RAND also met with schedulers and squadron training managers at the 1st Special Operations Wing to understand how they initially adapted to Eglin's new range scheduling system. The team also met with 98th Wing personnel and unit schedulers associated with the Nellis Test and Training Range, Nellis AFB. In addition, dialog between range stakeholders and managers attending the 2008 and 2009 Global Range Managers Conference, which ACC hosted, helped clarify the evolving manager viewpoint and included discussion of how managers view unit requirements. These meetings suggested the need for methods that would help schedulers build the mission profiles they needed for each sortie. The managers also felt that specific range requirements needed to be more explicit (e.g., airspace size and range attributes). The unit inputs also should be timely to help managers meet fiscal planning milestones and make OPTEMPO decisions that affect capacity. We developed an approach that used Ready Aircrew Program (RAP) mission sorties to help create mission profiles with specifications for existing and expected range activities. The methodology includes organizing sorties into training categories to provide a common framework for understanding the sortie in a broader combat-related framework. In the future, training program managers should update the tactics-based data as RAP sortie requirements evolve in the RAP tasking message and appropriate mission design series (MDS) AFIs. The objective is to establish a reason-

The final phase of this study identified changes in demand for Air Force ranges and airspace, challenges that arise from such changes, and possible Air Force responses.

Organization of This Report

Chapter Two presents an overview of current range supply, types of range demand, and processes for managing ranges. Chapter Three describes the changing environment for range use and the factors driving the change. Chapter Four describes the challenges the changing environment presents to local range managers and discusses information and strategies for meeting these challenges. Chapter Five describes the challenges for program managers and discusses strategies for meeting them. Chapter Six presents implications for the Air Force and offers our conclusions. Appendix A catalogs Air Force ranges and other non–Air Force range assets the Air Force uses. Appendix B discusses the CSE, describes RAND's range and airspace decision support tool and relates how the original tool was updated and expanded to include a broader set of aircraft than those covered in the original work. Appendix C illustrates the framework.

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able template that local instructors and schedulers can use to build sortie mission profiles. Range planners can also use the information for range configurations.

CHAPTER TWO

Range Supply, Demand, and Management: An Overview

This chapter provides a brief background on the current Air Force range and airspace inventory, the types of demand for ranges, and current processes for managing range use.

Supply of Air Force Ranges and Associated Special Use Airspace

At the time of this research, the Air Force had significant interests in 43 range complexes. (Not all are owned and/or operated by the Air Force.) These ranges generally have SUA set aside in the NAS and have ground environments associated with that airspace. Most of these directly support one or more wings. Figure 2.1 depicts the extent of military SUA in the continental United States NAS. A significant amount of the NAS is set aside for military use. Much of the designated airspace is not formally part of the 40-odd complexes. This section begins with a brief review of how the larger range complexes and nonassociated airspace are organized.

Elements of an Air Force Range Complex

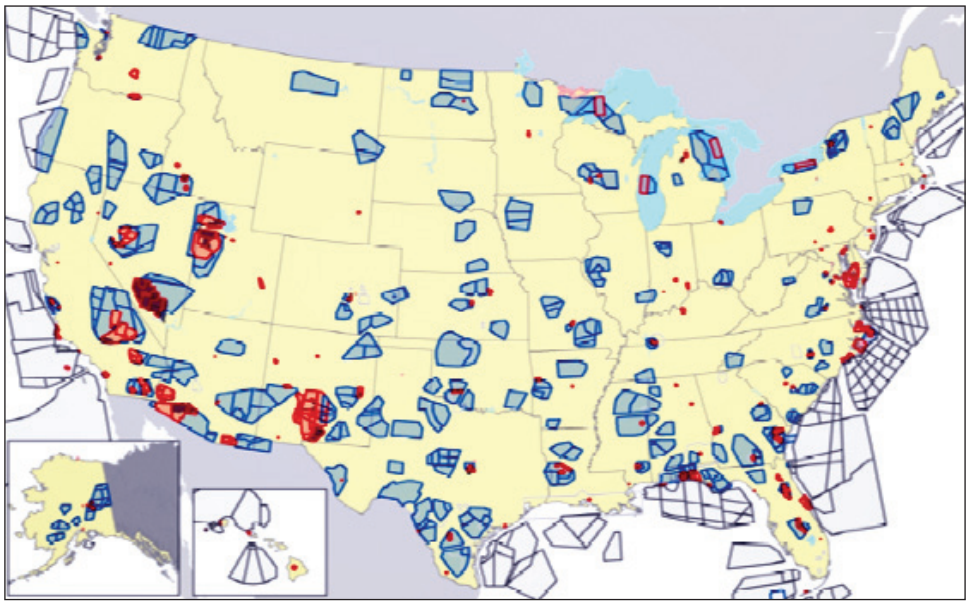
A military *range* includes both a ground environment and its associated SUA.

Special Use Airspace. Each range has SUA, which provides various levels of access based on the anticipated activity. The airspace directly over a ground range (referred to as a *restricted area*) is open only to aircraft using the range. Larger maneuvering areas may be less restrictive and may include

- **military operating areas (MOAs)—**used when an advisory is issued about military use. MOAs provide a larger area, often for tactical maneuvers
- **air refueling orbit areas or routes—**areas set aside for scheduled air refueling
- **low-level flight routes** (instrument and visual)**—**often used by high-speed military traffic on published flight routes to enter the target area at an altitude near ground level
- **drop zones—**needed for cargo or military personnel training parachute drops[1]
- **restricted areas—**used when the range activity requires separation from nonparticipating aircraft.

[1] Drop zones have not generally been considered technically to be SUA. However, given the need to restrict potential conflicts with civilian or other military traffic and the need for a sufficiently safe ground environment for Joint Primary Aircraft Training System–sized cargo pallets, AMC is seeking SUA-quality areas for airdrop testing and training. Discussions with AMC/A3T and AMC/A3R personnel, November 2007.

Figure 2.1
Military Special Use Airspace



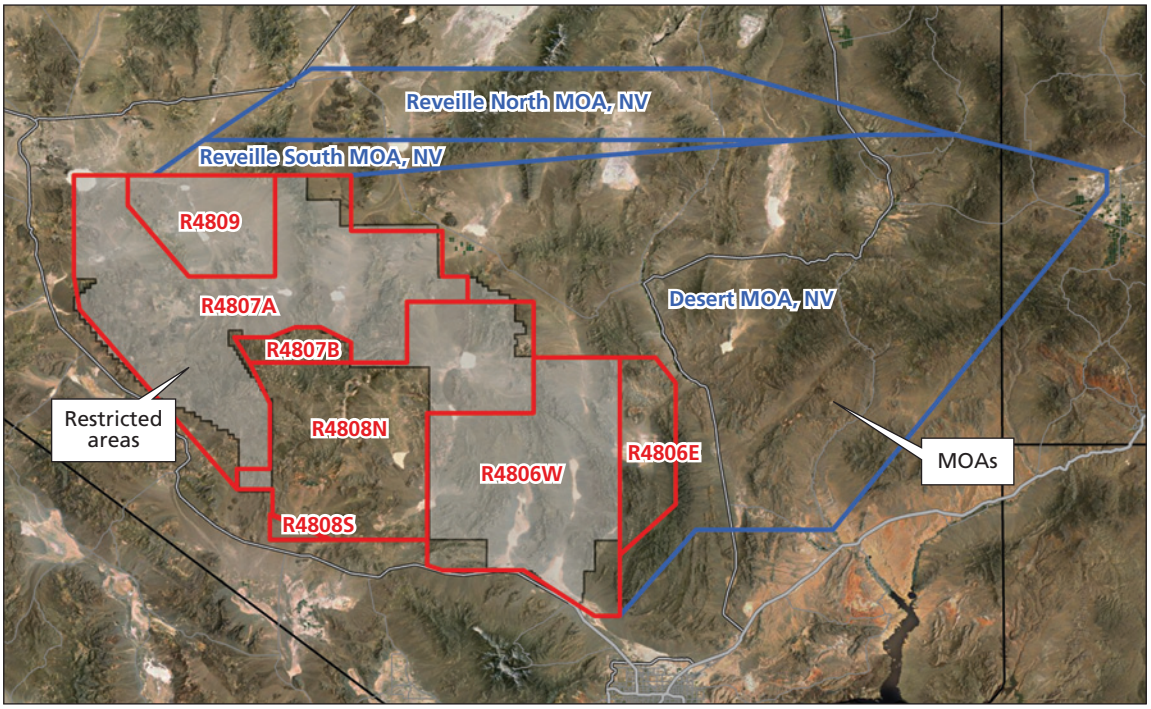
SOURCE: Headquarters U.S. Air Force, 2009.
NOTES: The map codes SUA as follows: Red areas are restricted to scheduled aircraft. Blue areas may be open to unscheduled aircraft and MOAs. Grey denotes warning areas over open water.
RAND *TR874-2.1*

Ranges that contain a variety of maneuvering airspace with one or more associated ground environments are considered *range complexes*. Examples of range complexes include the Edwards Test Range in California, the Utah Test and Training Range, the Nevada Test and Training Range, and the Goldwater Training Range in Arizona. Generally, each complex has a single scheduling and/or controlling authority. Smaller complexes also will contain a set of SUAs with or without a ground environment or formal range complex.

As an example, Figure 2.2 provides a close-up of the Nevada Test and Training Range, which is a particularly complicated collection of multiple ranges and SUAs, including MOAs, restricted areas, and low-level military training routes that lead into and out of the complex. In Figure 2.2, the eastern-most area is a MOA, and the red areas depict restricted areas.

Ground Environment. Ground environments are created to enable aircraft to maneuver directly over (or close to) a target scoring system, a strafing pit, or an electronics array that simulates a surface-to-air missile threat. A ground environment will often include a recording system that tracks and records events to document a test flight or training activity for later review, such as by the instructor and student. This capability may also be used to identify nonparticipating air traffic in or near the area to maintain a safe and secure area for the test or training activity. It is important to note that, as the Federal Aviation Administration (FAA) moves into the NextGen era, military airspace tied to a ground environment for test or training cannot be readily shifted when the NAS shifts in response to an event or weather.

Figure 2.2
Map of Nevada Test and Training Range Elements



SOURCE: Headquarters Air Force, 2009.
NOTE: Numerical designators beginning with the letter *R* indicate specific restricted areas.
RAND *TR874-2.2*

A restricted ground area is required when an aircraft releases training munitions or inert training shapes mimicking the flight and drop characteristics of aircraft weapons.[2] Restricted areas may also be required when activities involve the use of aircraft sensors (e.g., laser-ranging equipment) or electronic countermeasures.

Air Force Range Categories

We found it useful to categorize the 43 Air Force range complexes into the following five types:

- **Twelve primary training ranges** support both formal and continuation training programs.
- **Four major test range complexes** are designed to meet requirements to test aircraft, space, and weapon programs.
- **Two test and training range complexes** have a mix of training and test activity, and may also support tactics development.
- **Twenty other Department of Defense (DoD) ranges** are available for Air Force training and testing but are owned by the Army or Navy.
- **Five overseas range complexes**, located in Germany, Japan, and Korea, are used by the two U.S. overseas MAJCOMs (U.S. Air Forces in Europe [USAFE] and Pacific Air Forces [PACAF]) to support allied or coalition training.

[2] The airspace above and around a ground environment may also be restricted for nonparticipating military aircraft, not just civilians.

Appendix A describes these ranges in more detail, along with their locations and functions.

Demand for Range and Airspace Use

Air Force requirements for range and airspace are driven by the need for two activities: (1) test and evaluation and (2) training. Test and evaluation activities use Air Force ranges to evaluate the equipment and tactics necessary to field and sustain the Air Force's DOC to accomplish its operations. Training can be for very specific activities, as in a formal qualification course, or can be part of a general program of continuation training to sustain prescribed combat capabilities.[3]

The demand for ranges and airspace too often becomes explicit only at the retail level, the point at which a unit requests use of these assets.[4] Improving managers' understanding of range demand should improve the perspective from which they view test and training needs over time. This understanding should also improve the timeliness and precision of information flows. Given longer lead times and a broader view of users' needs, range managers can make more-informed decisions about allocating range resources to better meet their user's test or training intent. This outcome can create more useful range capabilities and should also lead managers to set OPTEMPOs that are flexible enough to respond well to unforeseen changes (e.g., changing deployment tasks).

Management of Air Force Ranges and Airspace

Key Air Force players at three distinct levels oversee range and airspace operations, optimizing the match between supply and demand:

- **locally—**wing commanders and range managers, who oversee the day-to-day scheduling and management of range and SUA operations
- **at MAJCOMs—**program managers within the MAJCOMs, who provide oversight and guidance for the range funding and policies at the ranges within their area of responsibility
- **Air Force–wide—**leaders in the Air Force Secretariat or on the Air Staff, who provide top-level oversight and guidance on resources, requirements, and instructions for all ranges and airspace owned and managed by the Air Force.

At the Local Level

Unit Commanders. Commanders must sustain their units' DOCs to be prepared for taskings they will receive during deployments. Historically, Air Force commanders have controlled the local training environment, including ranges and airspace, to ensure that they had access to the training resources they needed to achieve and maintain the DOC. Accordingly, some

[3] Appendix A describes the type and nature of testing and training activities in more detail.

[4] Specifically, we use retail level to refer to the formal transaction between the user and the range scheduler, in which the two agree on a schedule for the next week. Units provide sortie information, including call signs, and the scheduler confirms the reservation as outlined in the request. Wholesale level refers to a transaction earlier in the chain of events in which the unit commander lays out the unit's range needs for the next year. This information would outline blocks of time for range access but would not supply the specific information required for formal, retail-level scheduling.

wing commanders with assigned flying squadrons have range managers working under their authority. Owning a range generally helps ensure that the unit will have the infrastructure it needs to sustain a DOC. The DOC can be relatively broad, while deployment tasking could emphasize specific tasks associated with the DOC. As units become focused on deployment, they may seek range capabilities or capacity that exceeds what is available locally or sometimes even regionally (e.g., mission rehearsals with actual threats or with ground forces).

All MAJCOMs have directives and instructions that provide a baseline to help commanders develop a continuation-training program. Combat air forces (CAF) commanders must look beyond these directives to build an annual flying program that not only manages the flying hours allocated to their unit but also provides continuation training that meets basic operational qualifications and those required for expected deployments.

In a unit's deployment orders, the combatant commander's (CCDR's) request for forces may outline specific deployment tasks. Preparation for these tasks may require additional complex training sorties beyond those specified in MAJCOM training requirements. Accordingly, the mix of required sortie types can change from year to year and may or may not be included in the training plan forecasts range managers receive.

In planning and training for upcoming deployments, the commander must work from the context of unit, MAJCOM, and other directives that establish thresholds for safe and efficient aircraft operation, all of which will affect which ranges are used and when. These decisions are based on aircraft types, the desired DOC training outcomes, and safe practices, given the aircraft and human factors. They are reviewed at least annually, but generally do not change significantly except in response to an incident or equipment change. Other inputs the commander uses are shorter term than those noted above. These include changes due to deployment tasking the unit may receive. While deployment will not eliminate MAJCOM requirements, it could change the priority that some training would otherwise receive. Deployment may place greater emphasis on using a specific piece of aircraft equipment, tactic, or weapon than would exist under the general training program. The fact that deployment tasking can occur within the MAJCOM annual review and planning cycle makes it a short-term input relative to inputs based on the DOC.

As a result, the combat unit's continuation-training requirements for ranges and airspace may be difficult for range managers to understand and act on in a timely manner—especially when planning is incomplete or not timely.[5] Range managers serve many units in today's test and training environment. General MDS- and DOC-related MAJCOM supplements to Air Force instructions (AFIs) and RAP tasking messages have historically helped outline what units will eventually demand at the retail level, but range managers can no longer rely on these sources when determining quarterly range OPTEMPOs. Because tactics and deployment tasking are evolving rapidly, these sources may not inform range managers about the specific tactical demands units will make on their complexes. Similar sorties can have vastly different range requirements, either for the space needed or for special range support infrastructure

[5] The challenge appears greatest for continuation training. The documentation for test sorties and formal flying courses is thorough and includes definitive expectations for each element. What makes continuation training sorties more challenging are the variables in the unit DOCs, deployment tasking, and resources. For example, available resources may require units to adapt their training sortie mission planning to the appropriate locally available SUA. As a result, units in different locations may use areas of different sizes for the same RAP sortie type. The present documentation does not provide standards or guidance for range maneuver. This sortie profile information would help managers at all levels to be more deliberate in their range planning and operations.

(e.g., scoring and feedback systems, chaff, flares, supersonic capabilities, threats, ground target types). What dictates these differences is the context of the sortie play and its available training time frame, or its deployment tasking. Deployment timing may reduce the normal time frame for training or increase the sortie rate for a quarter beyond what would be normal in peacetime. Range managers can be blind to too much of this context. As a consequence, unit range and airspace demands can vary from year to year and be difficult to comprehend and plan efficiently. Managers rely on unit leaders to provide timely and complete information about sortie mission profiles.

Range Managers. When units "own" their range complexes, unit commanders usually delegate day-to-day management to a range manager, who schedules, coordinates, and implements daily activities. Today, many range and airspace managers are advocates who ensure that their own unit and others have access to sufficient training airspace.

Range managers have four roles. First, they operate the range or range complex. Second, they work with unit flight schedulers to optimize training opportunities for local range users. To a lesser degree they must also be responsive to nonlocal units seeking additional range access. Third, range managers seek access to ranges and airspace a unit does not own to fully support a unit's training or operating plan. Finally, they advocate for range improvements and help develop investment strategies that will anticipate future range use requirements.

Unit managers are usually embedded in the unit and must work closely with wing planners as the unit receives its flying hour allocation; training tasking messages (e.g., MAJCOM RAP tasking message); and, finally, any deployment tasking that may affect the type and pace of unit training sortie production and range demand. Because deployment tasking may be received relatively late in unit fiscal and activity planning cycles, deployment information could radically alter the unit's annual planning. Managers who are not embedded in units are even less likely to receive this information early enough to make informed decisions. They are likely to receive unforeseen requests from units whose range training windows are not long enough to cover their deployment tasking or from units that have higher priorities for local range and airspace access.

Program Managers at the MAJCOM Level

Program Managers. Traditionally, each MAJCOM holds primary authority for managing the ranges under its purview. The management goal is, of course, to strike a balance between the demand for range and airspace and the available supply. The command appoints a program manager to manage operations and oversee range managers throughout the command. This manager identifies and prioritizes range requirements across the MAJCOM, advocates for range sustainment and improvements, and prepares relevant policies and directives. Related activities include helping structure operating contracts and working with the acquisition community to procure monitoring and feedback systems for training or test support.

Part of the challenge is that range programs are managed separately from training programs. Range management must anticipate training requirements and plan within resource constraints. Program managers should be more explicit when range capabilities are critical to achieving desired program outcomes. Test program managers appear more sensitive to range costs because their range activities are usually billed directly to the program. This is generally not the situation with continuation training sorties.

Three commands—Air Force Materiel Command (AFMC), ACC, and Air Force Space Command (AFSPC)[6]—receive the bulk of range funding, but a total of ten MAJCOMs are responsible for Air Force ranges.[7]

Training Program Managers. These managers are responsible for drafting and disseminating training requirements and, at ACC, RAP tasking messages.[8] MAJCOM program managers also allocate flying hours to each wing. Flying hours are the fiscal basis for wing operations.

Managers use MAJCOM training programs to update AFI command supplements, set priorities, and provide policies on currency and other MDS-related issues that lead not just to safe and efficient execution by the units but to general direction that other supporting programs can use to make informed and timely decisions. The promise of RAP has been improving the collection of weapon events and currency requirements into a sortie package set in a tactical scenario.[9] MAJCOMs also set resource levels allocating flying hours to units annually and quarterly.

Today, the process does not provide enough objective details for full understanding of range demands. Mission profiles for RAP sorties can differ dramatically at the retail level. An objective set of authoritative range requirements is needed. Training program managers are also in the best position to link each RAP sortie or formal training sortie to the joint mission it objectively meets. This linkage and an authoritative range template would create a richer knowledge base that decisionmakers at all levels—retail, wholesale, and long-range planning and programming—can use to make informed decisions and/or trade-offs.

Likewise, within the training community, ownership of the training requirement and vantage point will enable managers to make qualitative decisions balancing live flight against simulators and/or other training means to take advantage of relative strengths. Training managers could create new RAP sorties and solicit weapons and tactics officers' suggestions on range infrastructure needs. This is the information we used to create templates, which would provide authoritative information to local instructors, range managers, and others for planning and scheduling access to ranges and airspace. Organizing the information as a RAP sortie objective mission profile will facilitate entry into the scheduling program and allow the training manager to connect the activity to joint missions and national security objectives.

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6 AFSPC's funding is primarily for the two space-launch ranges.

7 Even MAJCOMs—such as AMC, which trains airlift and aerial tanker mission forces—are increasing their range requirements beyond discrete drop zones, air refueling tracks, and low-level routes to traditional air-to-ground range and airspace areas because new systems require greater precision and integration with the ground environment. The ten MAJCOMs are ACC, Langley AFB, Virginia; AETC, Randolph AFB, Texas; Air Force Global Strike Command, Barksdale AFB, Louisiana; AFMC, Wright-Patterson AFB, Ohio; Air Force Reserve Command, Robins AFB, Georgia; AFSPC, Peterson AFB, Colorado; AFSOC, Hurlburt Field, Florida; AMC, Scott AFB, Illinois; PACAF, Hickam AFB, Hawaii; USAFE, Ramstein AB, Germany. The ANG is also often informally regarded as an 11th MAJCOM.

AMC forces are using the Airdrop Enhanced Logistics Visibility System and container drop systems in concert with supported ground personnel to increase the precision of airdrops. This has increased the need for such rangelike qualities as restricted areas and feedback systems (see Ritchie, 2009). AMC forces are increasingly integrated into major joint force activities that require extensive airspace and ground range environments (see also Whitney, 2009).

8 Other MAJCOMs are considering ACC's RAP approach to continuation training. RAP organizes training requirements for qualified aircrews within a broad context that can be linked with a scenario. Prior to RAP, training for qualified aircrews was a collection of individual requirements.

9 For example, a package might specify flying a surface attack tactic (SAT) mission in an air-to-ground attack scenario, which requires some means of incorporating threats and a target environment.

Some MAJCOM training managers are integrating advanced simulators with flying activities. For example, ACC training program managers provide F-15C/D aircrew training directives that allow pilots to count about 20 percent of the necessary time toward experience in an advanced tactical simulator. So, for example, "100 RAP SIM Mission hours out of 500 hours" can be counted from a total number of training hours (AFI 11-2F-15V1, 2007, p. 71).[10] Unfortunately, command training programs do little to define the expectations for range activities. RAP sortie types are generally defined, but few references relate specifically what a RAP sortie would require in terms of range, airspace, and infrastructure. MAJCOM range program managers could use this kind of information to make more prudent investment decisions about needed range capabilities. Units would then have additional guidance (beyond the flying hour allocations) to balance planning across ranges and other training capabilities. This is one area in which training managers and tactics officers at wing and unit levels must work together to make range requirements more explicit, given MAJCOM fiscal constraints and evolving combat requirements that may significantly alter what RAP sorties a unit flies. A focus on flying hours is insufficient.

Robbert et al. (2001a) and Robbert et al. (2001b) illustrated this need for training managers to take a more-proactive and -complete role in formulating range requirements. We consider this imperative, given the need to manage range resources more precisely where this is an Air Force responsibility and to help secure access to the range, airspace, and infrastructures of fellow services or host nations. In addition, linking activities (as the RAND Decision Tool does) to applicable joint missions will help provide a rational basis for allocating fiscal resources and set an appropriate priority for continued SUA access, once the FAA enters the more-dynamic NextGen ATM era.

Air Force–Wide Range and Airspace Managers

Several different players at Headquarters Air Force are responsible for managing programs that affect ranges and airspace across the Air Force. Managers at this level work with the MAJCOMs to provide resources for their ranges and associated programs. These managers also work with AFMC acquisition and system sustainment offices to provide new range systems and services. They monitor environmental, health, and safety issues and provide policy guidance that affects range operations productivity. They do these tasks in close consultation with MAJCOM commanders and program managers and work with stakeholders to help shape range capabilities and sustain access to the needed capabilities and capacity. They also advocate for range resources within DoD programming and budgeting processes.

Headquarters Air Force managers also coordinate service input and analysis for force structure moves and base mission alignments the Office of the Secretary of Defense (OSD) is considering. This includes helping identify unit priorities for ranges and airspace structure within the NAS.

The managers also coordinate with the other services on range and airspace issues and, as DoD's airspace executive agents, work with the FAA and international and foreign air traffic control agencies (e.g., EUROCONTROL).

These functions are concentrated in the following Headquarters Air Force organizations:

[10] The instruction allows unit commanders to count at least 100 advanced tactical simulator hours toward the 500-hour threshold a pilot needs to be considered experienced.

- **U.S. Air Force Deputy Chief of Staff for Operations, Plans, and Requirements.** This is the central Air Force advocate for managing ranges and SUA. This individual also communicates with the FAA and other air traffic control organizations through the FAA military office. The range program element manager is assigned here.
- **Assistant Secretary of the Air Force for Installations, Environment, and Logistics.** This office provides broad policy guidance for range operations relevant to safety and environmental programs. It also works closely with Headquarters AF/A3/5 on range operations and environmental cleanup.
- **Chief of Warfighting Integration and Chief Information Officer.** This office manages programs that provide range systems for feedback and control, as well as the range test and training environment.
- **Director of Test and Evaluation.** This office is responsible for Air Force test and evaluation programs and systems development.
- **Civil Engineer of the Air Force.** This office works with the U.S. Air Force Deputy Chief of Staff for Operations, Plans, and Requirements and the Assistant Secretary of the Air Force for Installations, Environment, and Logistics on range facilities and environmental management tasks.

It is important to note, again, that no single authority has ultimate control over all Air Force ranges. The MAJCOMs have authority over the ranges they operate. Military liaison with the FAA falls under the Air Staff. Because the Air Force is using ranges that other U.S. services and other nations overseas own, it is easy to understand that management must focus on securing continued access from a diverse set of actors, and not just conducting prudent day-to-day operation of the few complexes that the Air Force owns and operates.

CHAPTER THREE

The Changing Environment for Range and Airspace Use

The supply-and-demand relationship for ranges and airspace is dynamic, responding to shifts in training and testing requirements and other factors. This chapter describes the changing environment for range use and the drivers of this change. Specifically, we discuss

- changes in training needs
- resource allocation issues
- encroachment on range spaces from civilian sources
- the new NAS.

Adapting to Changing Training Needs

Since September 11, 2001, changes in the way the Air Force trains its aircrews have driven a greater need for more-robust, more-flexible range and airspace capabilities. Many of these changes have occurred at the unit execution level and have not been reflected in Air Force and MAJCOM training instructions.

Tightening Schedules

In recent years, unit commanders gained more authority over continuation training for their units,[1] the intention being to facilitate training for combat tasks anticipated for the next deployment. Units must still work within their DOC to maintain appropriate readiness levels. However, the ability to deploy and fight within a specific joint mission context is taking precedence, particularly for sorties flown late in the Air and Space Expeditionary Force (AEF) predeployment training cycle. As a consequence, a larger proportion of unit training operations for specific deployment requirements may be scheduled on short notice under tight deadlines.

[1] Sample verbiage from a typical RAP tasking memorandum for MDS aircraft and aircrew training reads

> Squadron commanders have the authority and are expected, when it is required, to tailor their unit's training program to focus on those missions, events and TTPs most relevant to their next AEF vulnerability. . . . This is not authority to completely ignore RAP tasking, but is direction to tailor and prioritize unit training to ensure that relevant AEF readiness takes more priority the closer units get to their AEF window. COMACC is willing to accept the risks associated with decreased emphasis on those DOC-tasked missions and associated [training] events not relevant to current GWOT operations. (HQ ACC/A3T, 2007.)

Further examples can be found in ACC, 2008, para. 1.b, "COMACC Intent," and in AFI 11-2F-16, Vol. 1, 2007, para. 1.5, "Training Concepts and Policies," and 1.6, "Ready Aircrew Program Policy and Management."

In discussions with MAJCOM and numbered air force (NAF) staff, we found that, in many cases, the AEF deployment schedule and associated training window may not be sufficient to meet requirements unique to the deployment. Range capacity to meet these requirements may be limited by day or night conditions or by the need to focus on combat tasks that require special range capabilities (e.g., air-to-ground releases working with a ground command and control element). This situation requires a MAJCOM waiver of DOC requirements to ensure that the deploying unit can meet the CCDR tasking. Lack of flexibility in meeting these requirements within the deployment time frame has resulted in a need for additional training en route or on arrival.[2]

Increasing Need for Realistic Range Capabilities

Shorter deadlines have increased the need for tactically robust ranges that expose units to realistic training. Commanders base their training efforts on their deployment tasking and lessons learned from previous and current unit deployments. During critical periods, the supported joint force air component commander has become assertive in specifying tasks and weapons that units can expect during their deployments.[3] Some of these tasks have required commanders to seek additional weapon events with live munitions or opportunities to train and rehearse the more-complex tactics needed when aircrews must work with a ground command and control element or with multiple types of aircraft. Training documents do require that training activity be as realistic as possible, but deployment tasking occurs well within training program review cycles.

Increasing Need for Realistic Small-Group Training on Ranges

Prior to 2001, flying training was generally organized by aircraft having similar configuration within type and with similar DOCs. Multiaircraft training opportunities only came together for large-force employment sorties conducted during exercises or Red Flag programs. However, in recent years, demand has been growing for multiple aircraft types training together in groups smaller than full-scale exercises. This development became necessary as commanders gained greater visibility into their anticipated AEF deployment tasking during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). They found, for example, that they needed to ensure that their aircrews gained the diverse types of experience demanded for such missions as CAS and combat search-and-rescue operations.

This development has had two consequences. First, units began searching for access to areas large enough to support SAT-CAS sorties or time-sensitive targeting coordination with the air and space operations center and intelligence, surveillance, and reconnaissance (ISR) aircraft. This increased demand stressed the local range, airspace, and infrastructure. However, units adapted by collaborating with other units to secure sufficient training space. For example, Air Force units increased their use of Army ranges, which had the additional benefit of increasing the skills required to work with both Army and Air Force tactical ground parties.

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[2] Discussions with USAFE, PACAF, and 13 AF personnel, May–July 2008.

[3] We reviewed a briefing from the USAF Weapons Center at Nellis AFB and discussed commanders' requirements with center personnel after visiting the Iraq and Afghanistan joint operations areas. Additional discussions at NAFs and USAFE confirmed these trends in unit demand for range capabilities. To illustrate, SAT sorties do not require live munitions, but AEF tasking and cycle priorities created the desire for more live releases.

Second, disparate units are developing common terminology as they cooperate in building common mission profiles. This trend is helping range managers understand how to plan for a set of sorties on the range. Coupling RAP sortie terms with a hierarchy of training categories (see Chapter Four) can help range managers better understand the demand. Our recommended training categories were created in this context. They provide a trans-MDS common language that can be used to coordinate similar types of tactical activities on a range or in simulators.

Increasing Importance of Simulators for Successful Training Outcomes

Since the 1990s, the Air Force has used simulators to augment ranges and airspace activity. Advanced simulators re-create cockpits and behave like the actual aircraft.[4] Advanced simulators provide pilots and aircrews with a very realistic virtual world called the *constructive environment*.[5] This provides basic geospatial data for a simulated aircraft flight and realistic, responsive threats that represent both surface-to-ground and air-to-air adversaries. Finally, FAA traffic management requirements do intrude on the mission profiles the simulator environment presents.

Even without simulated motion or realistic visuals,[6] advanced simulators allow aircrews to overcome negative training that occurs in peacetime training flights and enables pilots to train with realistic wartime tactics. For example, in advanced simulators, as in war, pilots should drop their expendable fuel tanks when engaged; this is not permitted on the range under peacetime procedures. Simulators also enable full tactical application of defensive systems, such as chaff and flares (Bell and Crane, 1993).

As advanced simulators have become available, they have become an important supplementary means of tactical training, even as actual flight time on ranges remains the primary way pilots and aircrews train. This development is making its way into ACC training directives, providing unit commanders with flexible training options. For example, beginning in 2007, ACC allowed F-15C/D pilots to accumulate up to 20 percent of their required tactical flight hours in advanced simulators instead of in the air.

Simulators have too often been perceived as substitutes for flying, a trade-off rather then a complement. The development we described above recognizes the strength of simulator use for providing certain advanced experiences that are not available in peacetime training programs. AETC integrates its advanced simulator sorties into its formal training and has provided sufficient financial support for systems that provide this capability for aircrews working toward qualification. Other commands have not always responded to provide financial support to

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[4] More specifically, these alleviate concerns that simulators might introduce bad habits (negative training) and that their use is not training "you would expect to fight." To capture the behavior of their objective aircraft as much as possible, they have the same configuration and can integrate with other simulators and in a common constructive environment with realistic threats and tactical situations. However, in some MAJCOMs, simulator upgrades have not kept up with aircraft upgrades, enough to lessen the value of tactical training in the affected simulators.

[5] Generally, constructive refers to computer-generated entities. Simulated refers to real people in simulated environments. Live, of course, refers to people flying real aircraft in real-world environments, albeit physically constructed to approximate a real wartime environment in a safe and secure area. It is possible, using current technology and advanced network capabilities, to create flying environments with various degrees of these capabilities working together. These environments can be used in either a test or training context.

[6] Visuals refer to the video screens that represent the pilot's view outside the aircraft. The resolution and frame rate should be sufficient to reinforce what can be expected in the aircraft.

their simulator programs. An advanced simulator can play a role in continuation training. More work needs to be done on training outcomes and deployment timing to fully address the potential for a more-integrated approach to sustaining combat skills.

Leveraging Live, Virtual, and Constructive Training

Live, virtual, and constructive (LVC) training is an emerging approach to that combines live training with virtual training. *Virtual* training involves real people operating simulated systems (e.g., a person operating an aircraft simulator). *Constructive* training involves simulated people operating simulated systems. LVC would either supplement or replace range threat emitters. The LVC threats may originate within a virtual environment computer program, from a manned advanced simulator cockpit, or from an instructor aggressor pilot manning an input station in an advanced simulator complex.

Fifth-generation aircraft may include embedded, onboard LVC capabilities. The F-22 has an initial version of this capability today, and the F-35 is slated to be fielded with it. It was first demonstrated by the Royal Dutch Air Force on F-16 aircraft, so legacy aircraft may be able to acquire the capability (National Aerospace Laboratory, 2009). Decisions are pending on these issues.

LVC training provides a means of creating multiaircraft small-group and large-force test and training environments without the requisite large SUA because the LVC-SUA would only have to be sufficient for the actual flying aircraft and not the support and/or adversary support aircraft.

Access to information about simulator and LVC capability will help commanders make decisions about where training and test objectives can best be accomplished.

Diminishing Range Funding

As the DoD budget contracts and supplemental funding for OIF and OEF are integrated into the annual defense budget request, resource levels are likely to drop for range operations and support. The 2010 DoD budget is expected to be the high-water mark for defense spending.[7] Throughout 2010, Secretary Gates continued to press the services to make changes to their operations to achieve additional savings. As defense spending tightens, budget constraints will affect not only acquisition of new range systems but also sustainment of present range capabilities. More than half of ACC's fiscal year 2009 budget for range operations and maintenance comes from contingency funding ($3 billion out of $5.7 billion total). Even with this amount, the command is unable to meet requirements, facing a shortfall of $475 million (ACC/A3R, 2009).

In addition, funding for range systems that monitor, track, and provide feedback must compete with funding for other requirements through the regular planning, programming, budgeting, and execution process. This fiscal environment may affect the level of support provided through range support contracts or stretch out modernization efforts.

[7] Multiple media reports and OSD information, December 2008 to May 2009.

Increasing Encroachment

Encroachment refers to the steady and persistent pressures other potential users are making on range assets. As populations grow around once-remote Air Force bases and ranges, they constrain how these facilities can be used. Encroachment is related to growing civilian populations in close proximity to ranges, energy development that seeks to place wind turbines on land now set aside for Air Force use, and increasing demand for sufficient airspace for the growth of civilian air traffic.

Urban Sprawl

Particularly in the eastern United States, ranges are becoming surrounded by development and urban sprawl. Where ranges were originally designed to overlap sparsely populated areas, these areas are now being squeezed by growing communities. Local citizenry generally becomes concerned about aircraft noise and the potential for range activity that may conflict with local economic development.[8]

In some cases, joint use of shared land may preclude some range functions. Examples of this would be releasing chaff or flares or using electronic countermeasures that can affect adjacent or joint-use land areas.

Energy Development

Energy development affects ranges in several ways. Wind turbine towers may create a hazard to low-flying aircraft and thus preclude low-level training. Wind turbines tend to be located in gaps with higher-than-average winds, which military aircraft use to mask themselves when crossing ridge lines. Electronic interference may also be associated with flying operations. Several NATO countries are exploring how wind farms affect military operations. In addition, EUROCONTROL is studying how they affect ATM and low-flying aircraft, including low-level military training flights.

Safety Footprints

Although it is counterintuitive, modern precision weapons require significantly more room on the ground than typical munitions, which do not have guidance systems. Since many precision-guided weapons have an extended standoff release point (and have some potential for malfunction), the areas of possible impact are much greater than for unguided weapons, which are released at a lower altitude. These concerns may make smaller ranges or ranges with environmental restrictions unusable for actual release of precision weapons for multiaircraft tactics and more-complex training sorties. Units must therefore use other ranges to accomplish these training tasks or mission rehearsals with actual ordinance. Given deployment timing, the issue may then be one of range *capacity* and not just range *capability*.

The same concern has become an issue for air-ground drops from cargo aircraft. In the past, drop zones were not even listed as SUA in the U.S. NAS (defined below). Modern airdrop systems are more precise than their predecessors, but they drop larger pallets, which, at the

[8] This also occurs overseas, where Air Force units must train locally using host-nation capabilities or return to U.S. facilities, either of which incurs some fiscal and operational costs. For example, F-16 aircraft based in northern Japan are using Alaskan training areas to meet an increased portion of their weapon and currency requirements. Discussions with Headquarters PACAF and 13th Air Force personnel, June 2008.

expected tactical release altitude, require a larger safety footprint. Some SUA managers and tactics officers have therefore advocated using a restricted area for training.

National Airspace System and the Next-Generation Air Transportation System

The FAA and EUROCONTROL are working diligently to transition the U.S. NAS and Europe into a system that bases traffic control on trajectories (FAA, 2007; Castle, 2008). (EUROCONTROL is responsible for ATM for Air Force aircraft when training in Europe and while transiting the European airspace.) The current approach uses a clearance system, in which a pilot proceeds to a specified (cleared) limit or level until further notice. In the new approach, a trajectory system, controllers and pilots will have tools that enable independent midcourse changes. In this shift from clearance-based control, aircraft will fly negotiated trajectories that air traffic control will manage. The goal of the new system, known as NextGen, is to increase the safety, security, and capacity of air transportation operations.

The consequences for ranges and airspace lie mainly in how ATM systems and air traffic control communications will evolve under the NextGen approach. The ranges and airspace the Air Force uses will be integral to the NAS, and current military SUA and range boundaries will be at risk with the implementation of NextGen in the United States will unless their use is not understood and defended. Those engaged with the broad national FAA ATM flow control require sufficient information for prioritizing and/or shifting military SUA when an event occurs that affects the smooth flow of traffic. Air Force personnel must be prepared to work in a dynamic environment.[9] In addition, pilots who have increased visibility into SUA use may request a course through unoccupied SUA, unless otherwise restricted. This dynamic nature of the new NAS will require a deeper knowledge about how SUA is being used and the priority of that use to adequately advocate for that use when an NAS event is pending or underway.[10]

The current en route system developed from the focus on using various ground electronic beacons as markers for aircraft navigation along flight routes. This en route structure avoids relatively large areas of military SUA, and this avoidance requires additional time and fuel. When implemented, NextGen will not be restricted to the legacy airway structure and will incorporate GPS-aided navigation and reporting, which does not depend on ground beacons.

As DoD's executive agent for the FAA's work on NextGen, the Air Force has been participating in development discussions toward the next version of the system's concept of operations. By participating in this way, the Air Force can help ensure that military priorities are explicit and that the NAS will give military activities supporting combat capabilities sufficiently high priority.

Both military and civilian aircraft follow the same en route flight rules. Military aircraft differ only when engaged in other flight activities, such as training or testing. These differences can be manifested in rapid descents and climbs, changes in headings, high- or low-speed maneuvers, and maneuvering in close quarters with other aircraft. It is, accordingly, important to continue to set aside areas in the NAS for tasks associated with test and evaluation

[9] The sense of dynamic here is the ability to amend routes and SUA schedules in near real time.

[10] Possible NAS events include severe storms moving through; delays at major commercial airports; or major event, such as the Olympics, that change airspace configurations and/or permissions.

and training. Setting aside large areas large enough for these dynamic activities will also help increase public safety by separating them from en route traffic. In addition, the use of electronic countermeasures, chaff, flares, and munitions can cause conflict with civilians. It is important therefore to consider the full effects of military activities when establishing separation criteria.

NextGen will also affect flight planning. In particular, NextGen will make military SUA use visible to all pilots during mission planning and during flights, allowing them to plan flight paths through SUA when the airspace is not being used.

Although NextGen addresses priorities for national security and homeland security air traffic, the concept of operations does not explicitly include military tests and training. As a result, key questions and issues about NextGen remain that are likely to affect range and airspace managers:

- How will NextGen decisions affect controllers and pilots now that they will have more-dynamic position reporting and actual range use information? NextGen is expected to make flight planning and en route procedures more dynamic.
- How will operational security considerations affect automatic reporting? The FAA expects military SUA reporting to become computer to computer, without a human in the data flow. Currently, the Air Force reports SUA use according to schedules. These reports enter FAA flight planning and en route systems. As reporting becomes automated, it will be necessary to ensure that the report provides enough information to establish access and safety of flight yet continue to allow reasonable operational freedom and security for military activity.
- How will NextGen affect the opportunity cost of shifting or not shifting training airspace, either to other ranges or to alternative training sites, such as simulators? If SUAs are not scheduled or if military aircraft are not present, civilian pilots could request routing through the area.
- How will range managers control the expectations of commercial and private pilots and the flying communities to which they belong? As dense air traffic, weather, or unforeseen events stress the NextGen NAS, the military's priority in an area could slip. Range managers will be challenged to defend military access to needed airspace.

Summary

The environment for range and SUA use has evolved in recent years and faces the likelihood of continuing change in years to come. These changes include

- tighter deadlines for scheduling continuation training in preparation for deployment
- a need for increasing realism for training in range environments
- looming resource constraints that may force difficult choices in range operation and maintenance
- encroachment of civilian activities on Air Force ranges and SUA
- the effects of the impending implementation of the NextGen flight management system.

These changes pose management challenges for the Air Force and suggest the need to anticipate them. We explore these challenges in more detail in the next two chapters.

CHAPTER FOUR

Range Management Challenges and Information Needs at the Range Level

According to several range managers and MAJCOM program managers, the hardest part of their jobs is to "understand the range requirement."[1] From the range managers' perspective, there are three challenges:

1. inadequate lead time in range scheduling, which inhibits range managers' decisions
2. lack of a strong understanding of the training or testing needs of the units using their ranges
3. lack of sufficient information to educate and inform key stakeholders.

The range manager must dig through layers of information the way an anthropologist sifts through artifacts to determine, somehow, who these people are and what they want.

This chapter provides an overview of range management challenges and outlines the information required to help meet these challenges. We also describe an information tool—CSE—that would improve managers' access to that information. While the program's primary purpose is scheduling access to range complexes, its intrinsic functions create, organize, and archive information about the scheduling transaction and range activities actually undertaken. The program also has a social network aspect because units, range managers, and decisionmakers can exploit it for reasons beyond scheduling. Other decision tools may also emerge to operate within the CSE-enabled environment to assist the manager in the unit planning and scheduling process. Such tools could apply CSE data to higher-level decisions related to mission priorities or force structure basing. These tools can be applied analytically even if the range in question is not currently owned or will exist only at some point in the future; examples of the latter include studies being done to support base selection for a new force structure.

Challenge 1: Range Scheduling Lead Times

The Timing Problem

Range managers do not receive good quality range request information early enough for informed adjustment of range schedules and management of range OPTEMPOs. As noted in Chapter Three, shorter deadlines for continuation training are causing units to change their

[1] Discussions with range managers, April 2008.

range requests from those initially submitted in their annual plans. However, because of budgets and contractual arrangements, range managers often cannot accommodate these changes.

Managers are also hampered by lack of a common information structure. A common structure would help them understanding user demand. Without more information about how sorties are using the range, it is difficult to posture its infrastructure and OPTEMPO to increase capacity. As a consequence, managers must make investment decisions without the guidance of specific and comprehensive requirements. Poor information leads to OPTEMPOs shaped more by the ad hoc availability of contingency funding and/or competition for MAJCOM operations and maintenance funds. DOC's deployment requirements define what the unit needs to meet desired training outcomes. Better information also yields better results when working with the test community and formal training programs, as their demands can be very specific. Further, the purposes and relationships to national security objectives for test sorties are well documented. DOC statements and MAJCOM training instructions alone are no longer sufficient to provide managers at all levels with the necessary information about user demand—both about the quality of the activity expected and about the capacity needed to meet short-term deployment taskings.

As CSE is deployed, the new web-based process can be more timely than current linear scheduling processes that rely primarily on one-to-one interaction and periodic conferences. Rules can be set in the program to notify units when an area becomes available or to ask another unit to give up the airspace. Communications among units and the range manager(s) can be as open or closed as operational security requires. Deploying a scheduling system that collects information about activities in the context of a sortie mission profile will help improve the transaction. If followed, the new approach to scheduling will result in a much richer and timely exchange of information between competing units and the range complexes that support them. To take full advantage of its capabilities, CSE should include a menu of objective tactical mission profiles to serve as templates for schedulers, providing a solid basis for long-term planning.

Speeding Up the Process

Range managers must shape the scheduling dialog by encouraging units to submit annual range requests in more detail and with the desired objective outcomes being part of the request. This will allow managers to make trades and build capability to anticipate rather than to react. This also means the detailed requirements are received earlier than they are now, which is primarily quarterly or in some areas monthly.

Unit Commander Roles. Range managers can work with unit commanders to address this problem. First, it would be beneficial for unit commanders to produce a high-quality annual training plan and transmit it to the affected range managers. To help open up range training opportunities, this annual training plan would need to arrive before the range manager's annual budget planning process. This would improve the ability of the annual flying plan, which ties sorties to the joint mission and combat tasks they support, to defend these activities properly.

Commanders should attempt to incorporate simulators and other training options into their annual training plan. Currently, only a few MAJCOM directives allow units to trade off simulator and flying activities. Among the directives, AMC's probably provide the most

integrated approach to simulators, CAF's the least.[2] Given more-detailed information in the training plan, range managers can focus on improving capabilities that units believe can *only* be achieved on a range, as opposed to in a simulator or by other means.

Next, commanders must communicate the full sortie requirement to the range and airspace community using a training category taxonomy, such as the one RAND suggests, based on RAP terms.[3] This information is not just the requirement for discrete pieces of SUA, but the whole range and airspace requirement within a sortie context. With the full sortie requirement, range managers will be postured to offer a wider variety of options to mitigate shortfalls in capacity during the scheduling period. This will also help the unit deal with SUA and the FAA and EUROCONTROL as ATM becomes a more dynamic stage for controllers and pilots.

Finally, after a sortie is complete, the unit commander can deliver a record of its actual range activity to the range manager. This will allow the manager to better forecast range cleanup but will also provide the unit better information about how it is using the range.

Using a Common Information Infrastructure. The 46th Test Wing created CSE, a web-based program, in recognition of the limitations of its range scheduling processes.[4] CSE enables a range manager to manage requests and document range use. Originally focused on test units, CSE has been expanded to include other Eglin range users, such as nearby AFSOC units, Eglin-based ACC units, and nearby AETC training units. In theory, it could be expanded to accommodate information from all ranges and MAJCOMs. The program contains a catalog of range capabilities, which allows users to communicate their range requests using mission profiles for each sortie. It enables an open, nonlinear approach as it structures the dialog between the unit and the range manager to provide information about how a request will affect other units participating in the program. CSE is also open in the sense that any unit can obtain an account and make requests via the program—they do not have to be based on or near Eglin AFB to schedule access. The program has rules for adjudicating scheduling conflicts and can notify affected users about training opportunities or conflicts with higher priorities.

Currently, schedules are open only at certain decision points. At locations with multiple units, range managers may hold conferences at these points. However, with the CSE, the schedule is open for additional requests until it is locked just prior to flight. Requests are dealt with immediately or are deferred if a higher-priority unit currently occupies the desired slot.

A common information structure will also allow managers at all levels to develop decision tools that use inherent CSE data and data arising from CSE scheduling transactions to inform management decisions.[5] It is also important to note that the expectation is that CSE

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[2] We reviewed continuation-training instructions for AMC, AETC, AFSOC, and ACC and met with the training program managers in each MAJCOM. For CAF during this period, only the F-15C/D instruction allowed squadron commanders to count simulator time (up to 20 percent of the 500 hours required) toward designating pilots as experienced. CAF simulator requirements were annotated in these instructions, but the flying and simulation requirements were not integrated.

[3] Note that the CSE scheduling program can accept this sortie information as a "mission profile."

[4] CSE was a joint product of 46th Test Wing and the Tybrin Corporation. Naturally, the program was originally optimized for test wings. However, combat-coded and training units adapted quickly to it, although they did not fully exploit the CSE archive's postmission capabilities. In addition to the CSE information, letters of agreement describe training operations on the range more completely. All this information is essential for full exploitation of CSE's capabilities, not only for scheduling but also for range management and headquarters oversight. Draft CSE documentation materials and discussions among RAND, 46th Test Wing, and the Tybrin Corporation, November 2007–June 2008.

[5] See Appendix B for a detailed description of CSE.

will feed the FAA mission planning systems that military and civilian pilots use. CSE provides a common tool for managers to view information about range activity.

Challenge 2: Understanding Units' Training Purposes

Training Tools and Requirements

Units are training to standards stricter than MAJCOM directives require and seeking more-realistic range environments for training. However, training documents for range managers have not made this demand for realistic training ranges explicit. Our 2001 research, for example, found that ACC's training program for the A-10 did not include a requirement for aircrews to drop live munitions in the continuation-training program, yet commanders frequently saw a need for this capability (Robbert et al., 2001a; Robbert et al., 2001b). The joint mission framework we presented in that work provides an easily understood expression for the combat objective. It is unclassified and can be used with various publics affected by range activity (see Appendix C for an updated statement of this framework).

When they schedule training on ranges and airspace, unit commanders must often work with several different range and/or SUA providers. Sorties, especially for longer-duration aircraft, may involve many range managers. However, individual range managers may not be aware of the full mission profile required in these cases.

Because unit range activities are not yet explicitly linked to joint mission requirements or national security objectives, range managers have little insight into the activity priorities, which makes it more difficult to manage range-use conflicts among users or even with the public.

To fully understand how units use the range over time and to ensure that a given unit maximizes its time on the range and achieves its training objectives most efficiently, the range manager needs to know the complete sortie requirement. Such information improves the ability of range managers to mitigate weather and maintenance delays, for example. In the longer term, the information makes it easier to adapt range operations to meet a unit's training objectives. Without this information, units will have to continue to adapt their own training requirements to whatever capabilities are available on a specific range. In addition, linking range sortie information to joint missions and national security objectives will help range managers mitigate air traffic priority–based decisions. Currently, the NextGen concept of operations anticipates assigning first priority to military traffic engaged in national or homeland security activities. However, it is not clear what priority level the system will assign to test and training activities. It would be useful if mission profiles for future test and training activities included information on related joint mission priorities. Sorties with mission profiles so tagged using RAP sortie naming criteria would allow better analytical sorting to help military and civilian personnel to make trades as emergencies develop that affect the smooth flow of air traffic.

In addition, with access to better analytic tools using data from CSE, such as the RAND Decision Tool, advocates for access to SUA will have information about how the sortie relates to one or more of these joint missions. Mission profiles using a RAP-related sortie name will gain from the joint mission relationship. The national security context will be more explicit to managers as they help the FAA sort out which traffic to reroute or delay.

Applying Mission Profiles to Range Use

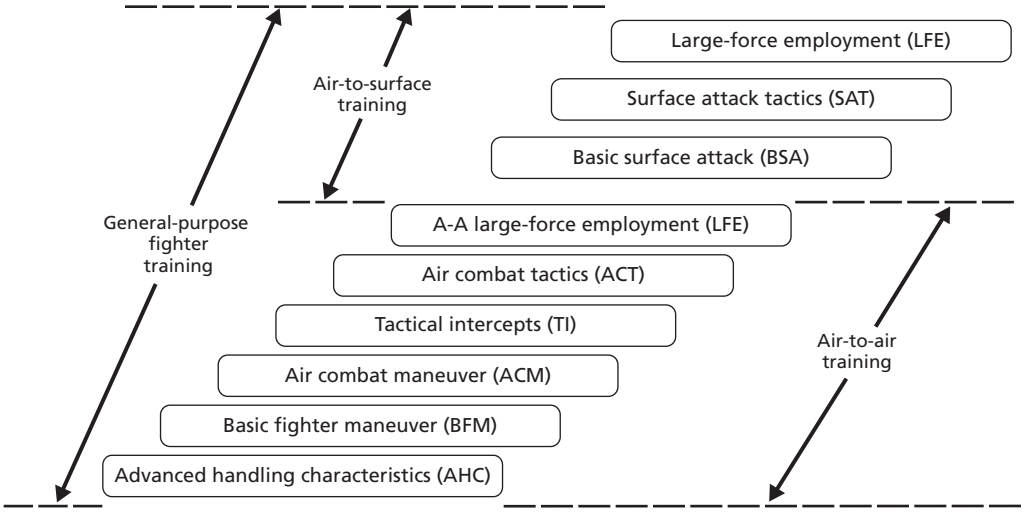
Range managers will have to work more closely with units to improve understanding of range demand. One way to do this is to create mission profiles for each planned range sortie. Using these profiles in scheduling continuation training will help range managers optimize range capabilities for that demand. When units schedule training, they can select one or more profiles, which will allow range managers to understand the tactical content of the training they schedule.

Again, CSE or a similar automated scheduling program can help with this challenge. Because such programs can automatically relate the operational requirements in the mission profile information to specific national security objectives, the linkage between the activity and the desired joint mission and national security objective is more explicit.

For the linking to work, however, the names for sortie mission profiles must follow the RAP sortie taxonomy, which should contain template information from tactics officers and training program managers that specifies the maneuver space and range capabilities required for each sortie type. This can include such capabilities as a radar threat, coordination with a tactical ground element, or aircraft sensors that work with other aircraft in CAS.

Figure 4.1 outlines the training categories for a general-purpose fighter, such as the F-16. Figure 4.2 shows how this approach could be expanded to create common sets of training categories for other aircraft making RAP sorties, including airlifters and other large aircraft. As in the notional fighter example in Figure 4.1, the focus progresses from operating the aircraft (handling and individual procedures) to more-complex tasks in a multiaircraft tactical training environment. Sorties conducted at the highest level of this hierarchy would therefore take place in environments approximating what crews would expect to encounter during actual combat, despite actually occurring in the safe and secure environment of training ranges and airspace.

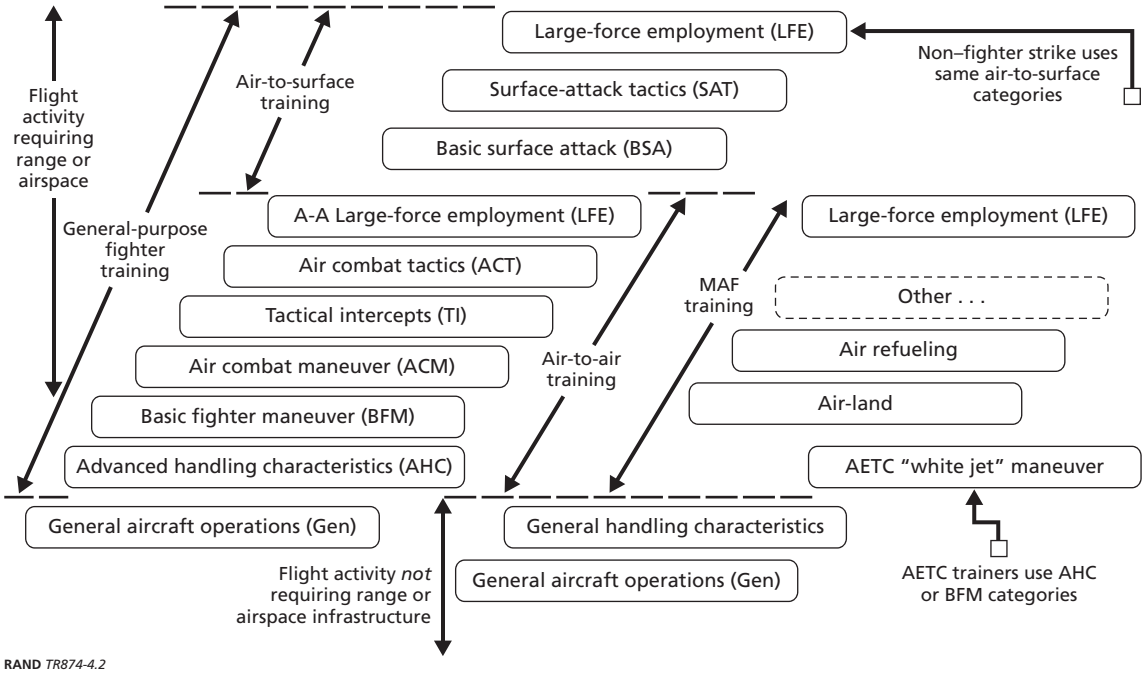
Figure 4.1
Example of General-Purpose Fighter Training Categories



SOURCE: Based on Marken et al., 2007, p. 4.
NOTE: Each training category corresponds to a RAP sortie type. Each category depicted builds on the skills in the category beneath it.

RAND *TR874-4.1*

Figure 4.2
Example of an Expanded Set of Training Categories



RAND *TR874-4.2*

If the automated scheduling network were fielded across a number of ranges, it could collect and organize range scheduling information throughout that region. Eventually, the capability might spread across the entire range structure. Given that and common sets of training categories like those illustrated in Figures 4.1 and 4.2, it is possible to document where sorties that can specify their range and airspace mission profiles and identify their objective training categories fall within a training category hierarchy. Sorties flown from the higher categories would link more directly to the CCDR's joint missions. Because the hierarchy builds on the lower categories, all activities can ultimately be linked to the CCDR's joint mission objectives.

Figure 4.2 illustrates how RAP sorties can be grouped within a training context; air-to-air, air-to-surface or strike, mobility sorties, and ISR are listed.[6] Sorties that fall below the bottom dashed line would be aimed at establishing basic competency in aircraft types. This would be the first step in building a training outcome with a specific joint mission objective. An example of a sortie with a specific joint mission outcome would be the SAT-CAS mission. The training outcome would be to provide strike support to forces actively engaged with an adversary. This sortie would fit within an advanced air-to-surface category, but its purpose would be more focused.

This approach would also allow classifying simulator missions in various categories so that training managers and other stakeholders can focus on the activity's desired objective outcome rather than on managing flying hours or some other fiscal metric.

[6] Nonfighter strike aircraft would use the same categories as fighter air-to-surface.

Challenge 3: Interacting with Key Stakeholders

Stakeholders Beyond the Military

Given the insufficient information on continuation-training demands, range managers find it challenging to defend range use or to alter range operations or boundaries. As discussed previously, because of a lack of clear insights into the intended training objectives, many range managers do not fully understand how the various units use the range infrastructure. Not understanding unit activity makes it difficult to make the necessary strategic decisions required to improve responsiveness and realism, and to sustain an efficient OPTEMPO. In addition, without the full picture, range managers are less prepared to defend SUA and range boundaries against sources of external encroachment, including increased airline traffic, energy development projects in remote areas of the range, and noise complaints. The managers are also less prepared to help prevent public use of the land or airspace next to the range area from further restricting range activities.[7]

Because range managers must often address public forums during lengthy public reporting processes, their information must be consistent and based on well-documented national security requirements. It must also be presented in a way the public can easily understand. A lack of information and a robust analytic capability will undermine the manager's presentation and hinder the ability to defend range operations. For example, range managers at Grand Forks AFB had to inform the public about how UAS training would be conducted at the base.[8] With information from tactics officers and training program managers, range and SUA planners were able to demonstrate how the new SUA structure would work for UAS. They were also able to directly link the UAS training to the CCDR's joint mission requirements and explain how the training supported national security. This level of detail greatly aided the range manager's efforts to explain the new range structure with the local public and the FAA regional office.

For FAA flight planning and for en route air traffic control, NextGen will require more detail on range use, and incomplete information about a unit's training objectives will impede the ability of range managers to meet NextGen's demand. Managing air traffic control expectations in the new NextGen NAS will be much more difficult than simply posting a static schedule. Managers must respond to FAA flight planning and en route requests for civilian use of military SUA and be ready with the appropriate information to defend scheduled activity when emergencies create restrictions to the smooth flow of aircraft traffic in the NAS. NextGen's goal is to increase the capacity of the NAS to handle air traffic. This is not incompatible with military SUA, but the new systems for ATM here and in Europe will create new information demands on managers and may collapse response times and schedule flexibility when events occur affecting the NAS air traffic flow.

At the range manager's level, NextGen-era changes provide an opportunity to shift and reconfigure the airspace structure as the NAS shifts dynamically in response to unforeseen events, such as weather (e.g., large fronts and thunderstorms). However, the range manager currently lacks the sortie context and knowledge base to take advantage of these opportuni-

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[7] One example of such a restriction would be nearby commercial airline traffic restricting the use of chaff on a range.

[8] The effort at Grand Forks remains under government and public consideration, but the airspace plan was based on how unmanned aerial vehicles were being used tactically and on challenges that the Nevada Test and Training Range at Nellis AFB had to overcome early in its program. (Headquarters U.S. Air Force, undated.)

ties. Making the demand more explicit through a CSE scheduling process that organizes sortie requirements around a tactical mission profile is a step in the right direction. In addition to the sortie's full range requirements, it also requires the context for the role and training intentions of the sortie. It will not be possible to shift the airspace if it is tied to a ground environment (e.g., threat array, targets). In that case, information from the mission profile would help prioritize sorties if the potential shift would reduce the capacity of the range complex. Where now conflicts are worked directly with local and regional ATM entities, NAS adjustments may now be national in scope and affect flight planning more than en route control. Without a higher military authority in the FAA national command center, the manager will be at a disadvantage relative to the major airlines and other stakeholders. In the past, local range and airspace managers were able to coordinate with regional ATM authorities. In the future, ATM coordination may require a national authority. It will be important to provide whatever level that is acting sufficient authority to work across MAJCOMs with these stakeholders. The airlines have placed personnel in the national command center to help broker airport and en route capabilities when capacity decreases. It will be prudent to take steps to ensure that the military personnel currently serving in the national center also have this authority for military activities. To use this authority effectively, they will need greater awareness of military SUA activities.

Responding to Encroachment

To mitigate the effects of persistent encroachment on range capabilities and capacity, managers need a clear and concise story about how ranges are used and needed. Their arguments must be based on joint mission and national security objectives, because these objectives merit a higher priority for use of resources than do such alternatives as en route air traffic or use of Bureau of Land Management land for energy development.

An automated scheduling tool (such as CSE) and related programs could give range managers a means to argue for range operations and range use. For instance, embedding range use information in an automated scheduling tool will help range managers build a body of information about range activities that can be used to defend and advocate for their range. The scheduling tool captures the information that will help range managers build more timely and complete documents, such as range environmental impact statements. Complementary programs that enable a focused study of range operations can also use the data the tool collects.

An enterprise-level executive authority would help mitigate issues with ATM stakeholders and help respond to encroachment. This authority would require information about the projected SUA use linked to the purpose of the activity and, therefore, its priority. The authority would require an information basis to help mitigate the more invasive outcomes possible as unforeseen events develop in the NAS. The Air Force is considering such an authority, in which AFSPC, ACC, and AFMC would each have a role under a steering group administered by the Air Staff.

Summary

CSE provides a much more transparent and fluid means of scheduling range infrastructure than do existing procedures. In the process, it creates a new information environment in which units, managers, and decisionmakers can exploit using the CSE report capability and analytic tools (e.g., RAND Decision Tool, ATAC Corporation's Base/Range loading simulation).

The new information environment helps standardize how the range community talks about requirements and expected use through its common architecture, range catalog, data library, and sortie mission profiles.

Range managers need assistance from MAJCOMs and above in providing the guidance and broader contexts for range activities. In particular, they need sortie templates for training programs. In this regard, range communities have worked well with tactics officers and MDS experts in designing range and airspace areas for new systems (e.g., UAS in North Dakota) (Headquarters U.S. Air Force, undated).

However, these templates quickly become outdated when training changes, for instance, to adapt to conditions in ongoing engagements in Iraq and Afghanistan. An automated scheduling tool's data format for mission profiles could therefore facilitate this process.

In addition, range managers need a way to match demand to range capabilities. MAJCOMs rely on complexes that they do not own and operate to assist in unit training window. They need a larger organization to help coordinate multicommand arrangements. With greater information fidelity and analytic tools, managers may see regional and national patterns of use that can be changed to create additional capacity in the present test and training range infrastructure. This is probably even more important because meeting Air Force range requirements requires access to range complexes that the Air Force does not own and operate. Making prudent trade-offs to improve utilization requires a more-strategic information vantage point than now exists.

Creating such an entity would also help advocate for Air Force test and training activities in the NAS when changes are proposed or when unforeseen events occur. It would also help create a means of informing a global management vantage point using CSE as a foundation. The Air Force is putting an executive authority into place that will rely primarily on AFSPC, ACC, and AFMC acting with the guidance and direction of a steering group. With sufficient authority, the executive authority working with the steering group may help meet these challenges in working across MAJCOMs, services, and the many range-area stakeholders.

Finally, range managers must exercise foresight and advocate for range improvements by developing investment strategies that anticipate future range use requirements. The various MAJCOM RAPs do not provide enough information about desired range capabilities to help range managers with operations planning and long-range investment decisions. RAP does outline what the MAJCOMs expect in terms of capacity through total sortie requirements and flying-hour allocations. However, this information is not precise enough to forecast what the actual range demand might be for a combat-coded unit entering the AEF training cycle or units deploying with area-specific mission requirements.

CHAPTER FIVE

Challenges for Range Program Managers

Like local range managers, the range management community at Air Force MAJCOMs and Headquarters Air Force requires richer, more-complete information to optimize use of range resources and meet range demands of many users. These managers also need more-precise range use information to better define the demand on ranges.

This chapter provides an overview of the range management challenges from the program managers' perspective that we will discuss in detail in the following sections:

- The MAJCOMs need well-defined, explicit range training requirements.
- Range training outcomes need to be linked explicitly to joint missions and national security objectives.
- Range and airspace capacity are not being used efficiently.
- Effective range and airspace advocates are needed at the program management level.
- NextGen planning needs to be emphasized.

MAJCOMs Need Well-Defined Training Requirements

As with local range managers, program managers continually seek better understanding of range requirements.[1] While formal training and test programs are structured well in advance in deliberate planning efforts, MAJCOM continuation-training programs are often not planned far enough in advance to be integrated well into the Air Force's planning and programming framework. In the absence of these requirements, it is difficult for range program managers to conduct the detailed planning necessary to develop and sustain range operations.

In addition, the anticipated loss of contingency funding, which has supported many range training operations since September 11, 2001, will force ranges to operate "smarter" or to focus on a few priority units. MAJCOM and Headquarters Air Force program managers will also need timely and coherent information about range requirements and their relationship to satisfying CCDRs' warfighting requirements to compete effectively for available funding.

Plan Based on Training Requirements Rather Than Constraints

There are two major steps the Air Force can take to respond to these challenges. First, range program managers should require their training program counterparts to prepare training

[1] Discussions with range managers at the Global Range Manager Conference hosted by ACC in Newport News, Virginia, April 2008 and April 2009. This statement or statements like it were repeated during almost every visit conversation we had with personnel working range operations and scheduling, including former range managers.

directives and documentation that specify required training resources and are not constrained by current capabilities. Second, tactics officers and instructors need to play a larger role in specifying range requirements. As new tactics, techniques, and procedures (TTP) are documented by the tactics and instructor communities for each MDS, the standards can evolve over time. One way of managing this process would be to use a wiki-style web tool (a collaborative website on which the pages can be updated and instantly published by users, with no special equipment required other than a web browser and access to the Internet). A MAJCOM training program manager could create such a site for each MDS aircraft. RAP sorties would be diagramed with range requirements, including expected instrumentation, the tactical environment, and the need for such items as chaff or flares. In addition, the site could contain a template tying training objectives to range requirements. TTP authorities can update the standards by allowing local and MAJCOM tactics officers, weapons officers, or training instructors to make changes to the site, but program managers would maintain editorial control.

If the data format used conforms to an automated scheduling tool standard, it would be easy for units to use standard tactics-based requirements to seek range capabilities and determine capacity of a range in meeting the requirement.

In some cases, tactics officers and training program managers have worked successfully with range program managers to define the range requirement. One such case took place when bomber program managers were seeking more-efficient and more-current operations-focused training airspace across portions of western South Dakota, eastern Wyoming, and Montana.[2] Range program managers were able to create an innovative airspace structure designed to meet key training objectives. This is also being done for remotely piloted vehicle SUA, primarily over North Dakota. The system implemented in that case may allow units the flexibility to rotate training among different surveillance areas while conforming to FAA flight rules for UAS aircraft (Headquarters U.S. Air Force, undated; Cartwright, 2008b). This desired training outcome was derived from the joint mission lessons learned and translated into a tactics-based template used to size the various areas in the new structure being considered.

Objectives

Although test programs and formal training generally have well-defined objectives linked to very specific outcomes, continuation training is often less definitive in how it supports specific joint missions and national security objectives. The lack of an effective strategy for linking range training objectives to the desired joint mission capabilities has a number of important consequences. Members of the public who live near ranges may, because of conflicting interests, seek to minimize range activities. Public understanding of the national security implications of range activities can improve their acceptance. In addition, in the competition for budgets, MAJCOM and Air Staff program managers must be prepared to articulate how range activity enables the joint mission effects CCDRs desire. The present information structure makes it difficult to recognize patterns of use that stretch across regions and even the nation. Neither the unit nor individual ranges will have complete sets of data, especially with the reliance on ranges and SUA that the Air Force does not own and operate. Without a sufficiently high vantage point, decisionmakers are hard pressed to make informed decisions to defend and sustain access.

[2] From discussion with range managers, Global Range Managers Conference, 2009.

Build a Tool That Links Range Activities to Joint Missions

Again, an automated scheduling tool that uses mission profiles for each range sortie will facilitate responding to this challenge. The tool would operate as a multisided platform to structure the scheduling transaction.[3] Rules that govern the scheduling tool's transactions dictate how information is provided; shared; and, most important for the program manager, archived.

To implement this strategy, the range and airspace executive authority should ensure that automated scheduling tools include information linking the sortie being scheduled to a joint mission.

Ranges and Associated Airspace Are Not Being Used Efficiently

Three factors contribute to inefficient utilization of the Air Force's total range capacity:

- Many flying units have joint mission requirements that exceed either the capabilities or capacity of their local ranges. As a result, the units must seek training opportunities at other range complexes to ensure they are prepared to meet all the CCDR's mission requirements prior to deployment.
- The AEF training cycle can underutilize ranges and airspace, particularly during its early phase, when a unit is being reconstituted after returning from a deployment. As a result, the local range complex may have very limited use until the unit ramps up its training demands in preparation for its next AEF deployment.
- Although MAJCOM program managers have the authority to help balance unit demands across range capacity, the range managers who are scheduling the ranges often report to several MAJCOMs and even other services.

As a consequence, some ranges are underutilized, while others are saturated.

Range and Airspace Advocates Are Needed at Higher Levels

The Air Force needs new authorities at the Air Force–wide and MAJCOM levels. First, the Air Force needs a servicewide executive authority that has broad responsibilities for maintaining scheduling systems and processes. Today, each MAJCOM serves this role individually. The evolving range and airspace executive authority could emerge as an enterprisewide entity to meet this requirement. Next, program managers need the authority to help sustain ranges through enterprise system upgrades and to help MAJCOMs seek efficiencies in range operations.

As this research was being conducted, the Air Force began implementing an executive authority for range management. Although this proposal does not change range ownership,

[3] Multisided platforms bring together two or more interdependent communities and facilitate interactions and interdependencies among these communities (Boudreau and Hagiu, 2008). For example, CSE operates as a scheduling program for users and range managers. The program structures the scheduling transaction and, through its operations, has the potential to create a social network of users and managers. We postulate that users can benefit from this network even if they are not part of the core interaction but have a role within the broader context of the program. An example of this would be the RAND Decision Tool (Appendix C), in which template information and the linkage to joint missions provide operational justification for range design. While not required for the core scheduling transaction, this information does provide users a template for modeling expected use and does provide managers information to help them structure the range complex. The sides involved in the transaction provide the tool updated information on range capability.

it does vest all Air Force range management responsibilities in three MAJCOMs—AFMC, AFSPC, and ACC (instead of the current range management by all 11 MAJCOMs). The proposal also would provide an executive authority for guidance to help program managers manage and balance capabilities and capacity across the range enterprise. If this executive authority were combined with the new information environment shaped by a multisided platform program, such as CSE, managers at all levels would have access to information related to range capabilities and capacity.

Improve Range Information to Balance Training Needs

The Air Force also needs a strategy that makes mission priorities visible to both program managers and senior Air Force decisionmakers. With more information, program managers can ensure that decisions pertaining to range maintenance funding and range operations contracts anticipate surges in range OPTEMPO. This strategy should help balance local range capabilities with off-station training opportunities and provide units with the operational flexibility they need to meet their training requirements.

To ensure that units can continue to maintain readiness requirements and be prepared for deployment tasks, program managers may need to assign a priority based on the unit's position in the AEF training cycle. MAJCOM program managers may also need to consider the number and type of units located near a range when making priority, base, or DOC mission changes. An automated scheduling tool and related analysis tools could help MAJCOM program managers model changes to make more informed decisions and guard against these drawbacks.

NextGen Planning Needs to Be Emphasized

Air Force ranges are under pressure from a number of sources of external encroachment, particularly the introduction of the NextGen NAS. To defend Air Force interests, range program managers must be prepared to speak about the importance of ranges and airspace before various public audiences and stakeholders.

Establish an Advocate for Airspace and Ranges at the DoD Level

Range program managers must articulate the need for ranges to a diverse set of audiences, such as OSD, Congress, and the American public. To serve as a successful advocate for ranges, program managers must understand the broader demand for ranges, Air Force–wide, and how range activities correlate with combat capabilities.

The Air Force should also establish an operational-level counterpart to work with the FAA during NextGen system implementation. This could expand on the present military offices working within the FAA and be under the authority of the new Air Force executive authority. NextGen will significantly change how pilots and en route controllers use information during mission planning and en route. A deliberate planning effort is necessary to ensure that information passed to FAA systems is used appropriately. Military personnel working with the FAA will need better information about the nature and priority of any SUA activity being done.

In many potential NextGen scenarios, the priority for airspace is the smooth flow of air traffic. However, when air traffic is disrupted due to bad weather or other factors, an assertive Air Force representative will be needed to mitigate the potential negative implications for sched-

uled range and airspace users. The decision authority will almost always be beyond the authority or scope of any one range complex, MAJCOM, or even service. To counter this potential (and persistent) encroachment, the Air Force will need a representative who can act with the same authority as the other air traffic stakeholders (major airlines, FAA, etc.). This function would accrue to the new executive authority the Air Force is creating to help lead range and airspace operations space management and would have three key planned responsibilities:

1. meeting user requirements for operating space
2. enabling range capitalization according to Air Force corporate priorities
3. organizing, training, and equipping the operating space enterprise.

The military office at the Air Traffic Control System Command Center (ATCSCC) would take the day-to-day lead on these. This center directly supports FAA air traffic services and hosts stakeholder representatives from the National Operations Control Center, the Air Transport Association, and the National Business Aviation Association. Its aim is responsive restoration and dynamic maintenance of critical NAS services.

The ATCSCC response to an air traffic event or disruption is to work collaboratively with the controlling en route and terminal authorities, the major airlines, military, and general aviation associations to smooth the flow of traffic through the NAS.[4] As an example, to deal with a weather anomaly, the center will coordinate to shift traffic away from the disturbance. Direction may take place before takeoff as flight routes are shifted to underutilized or lower-priority airspace. ATCSCC will also use delays to help mitigate the effect of the event in the NAS. Currently, when conditions permit, ATCSCC collaborates with stakeholders that chose to participate. With sufficient information, the military office at ATCSCC can assist along with the other on-site representatives. These military personnel are constrained by the depth of information the present system gives them. For example, they may only have SUA entry and exit times and aircraft call signs. Their counterparts in the airlines have more detailed information. This helps the airline make informed decisions and mitigate adverse effects on their overall operations as emergencies develop. The airlines can also call on analytic cells in their operation centers to help inform decisions as the new NAS flow evolves around the event.

To meet its expectations for smooth operation and management of en route air traffic and NextGen flight planning, the FAA may aggressively seek to use any unoccupied military SUA. Already, the FAA has sought access to military airspace during periods of high-volume traffic, such as Thanksgiving week. As NextGen makes airspace more clearly visible in real time to the FAA, its threshold for making such requests may decrease, perhaps even becoming a routine element of traffic management. Over time, the FAA's new ability to determine and act on SUA status will pressure the Air Force to open military test and training areas to en route traffic. The FAA expects military SUA scheduling to depend on machine-to-machine coordination, implying an automated range and airspace scheduling system that would feed into FAA flight planning and en route systems. Ultimately, what is needed is a human-based system aided by automated tools that adapts and balances commercial needs with national defense priorities.

The executive authority for airspace and ranges will require better understanding of the desired test and training outcomes and the ability to link the activity to a joint mission explic-

[4] This collaboration is so important to successfully working through emergencies that the major airlines and the military have posted personnel in the national center that monitors and manages the en route air traffic flow in the NAS.

itly. Part of this role requires appropriate advocacy for sustaining access to the required range infrastructure and SUA structure in the NAS and overseas. At least four program areas influence continuation-training outcomes: (1) capital investment accounts for range infrastructure, (2) constructive training capabilities embedded in aircraft, (3) simulators, and (4) operations and maintenance costs, primarily for flying hours. Decisions in one portfolio can affect costs or benefits in the others. For example, investing in embedded training capabilities has the potential to reduce the need for simulated threats on a range complex. Similarly, a decision to reduce flying hours might make it difficult to receive full value from investing more in a regional than in local range capabilities. The intent here is not to diminish MAJCOM authorities but to highlight consequences of decisions in any one program. Particularly because so many external stakeholders have range issues, this knowledge would help the Air Force create the voice it needs in these external venues. Currently, however, there is no systematic way of harmonizing what are now independent program decisions.

Management efficiency should improve as an automated scheduling tool becomes the core means of organizing information about range use. It would provide an ability to analyze range resource and utilization data on a local, regional, or higher scale. If a proactive, Air Force–wide, range and airspace planning activity marshals it effectively, this analytic capability could be used to optimize decisions that contribute to training effectiveness.

Summary

Program managers need a means of collaborating across MAJCOMs, other services, and foreign hosts to improve range opportunities for Air Force units. This collaboration can be facilitated through a common data approach—enabled and enforced by an automated scheduling system—that will help units as they seek sufficient training opportunities, help range managers understand range use and anticipate range demand, and help program managers make analytical decisions intended to improve and defend range capabilities and capacities.

The constrained fiscal environment and a more-dynamic operational environment will require program managers at the MAJCOM and Air Force–wide levels to become more-informed range advocates. Better advocacy is necessary to defend funding for ranges and to argue the need for range capabilities and capacity in a context of emerging encroachments.

NextGen and similar ATM foreign programs provide major motivations for developing an Air Force–wide vantage point from which to oversee SUA management and priorities. Users in the NextGen era will expect the smooth operation of the en route air traffic system to take priority over many other activities. In this new area, pilots and controllers use flight information to adjust flight routes differently, and pilots will be able to remain their positions to other aircraft using GPS-aided position reporting equipment. As a consequence, the en route structure may not be as wedded to geographic points, except at airports. When unforeseen events occur, national traffic flow can be adjusted centrally.

In that new environment, the reporting of schedules for military activities in SUA to the FAA flight planning and en route systems should be thought through carefully. Those coordinating with the FAA and other users will require deeper knowledge than they presently have about activities conducted in military SUAs to mitigate problems as they develop.

CHAPTER SIX

Conclusions, Implications, and Recommended Responses

Many challenges arising from the changing environment of range management can be addressed through information and data improvements. With better information, the range scheduling environment can work more like a marketplace in which users understand range resources more clearly, range managers and program managers understand training needs and range demands more clearly, and decisionmakers have data about range needs to inform resource allocation decisions and to advocate for protection of range assets. This improved information environment should enable units to help make range operations more efficient and effective through a more timely and explicit expression of their range demand. Table 6.1 summarizes changes in the range environment, the challenges these pose, and key concepts for responding to the challenges, together with specific forms of action that these responses might take.

Changes in the Range Environment

The far left column in Table 6.1 sums up these principal changes in the range environment:

- changes in training needs that often result in shorter-notice scheduling for range time and a greater demand for realism on ranges
- a deepening scarcity of resources for maintaining and operating range assets and making prudent investments
- the impending implementation of NextGen
- encroachment on range space from civilian sources, such as population growth and commercial development.

Table 6.1
Overview of Range Environment Changes, Challenges, and Responses

Changes	Challenges	Responses	Action Steps
Training	Understanding training requirements	Specify required training resources	Develop tactical training templates
Scarce resources	Building realistic environments	Collect usage data	Make an automated scheduling tool standard for archiving data
NextGen dynamic scheduling	Improving knowledge of range activities	Define range expectations	Use an automated scheduling tool to manage range "market": • Use tools at higher levels • Use a data standard compatible with NextGen system use
Encroachment	Understanding competing needs	Manage at the supralocal level	Adopt an enterprise vantage point for managing assets

Challenges

As we have noted, these changes pose significant challenges for range management at all levels. In Chapters Four and Five, we described these challenges from the perspectives of the managers responsible for dealing with them. The second column of the table reflects these:

- developing a clearer understanding of training requirements, both as these relate to the content of specific training activities and to the regional and national demand for range scheduling
- building more-realistic range environments
- portraying range use in real time will create a new set of information for pilots and controllers[1]
- understanding competing priorities for range and airspace allocation.

Several of these challenges can best be addressed in a broad framework that allows comparison with other means for training.

Response Concepts

An implication running through all these challenges is the need for enhanced information and, perhaps even more important, a higher-level perspective on range demand and use than the current information infrastructure affords. These challenges require managers at all levels to possess a more depth of information about range demand, use, and user expectations than they currently do. As summarized in the third column of Table 6.1, our analysis suggests four main concepts for responding to these challenges:

- **Specify required training resources.** Statements of range and airspace requirements need to be more specific, more comprehensive, and more timely than they are at present. Under the current model, some ranges may be underutilized, even as some units need more range training opportunities. In addition, managers lack timely and accurate information to make knowledgeable and prudent decisions about range contracts, personnel, and investments. With a broader view of and more timely information on training needs and desired tactical outcomes, program managers can ensure that decisions about MAJCOM operations, range maintenance funding, and range operations contracts properly anticipate surges in range operating tempo. Expressing unit demands in terms of sortie mission profiles will allow all managers to better understand the full requirement for the sortie, not just the disparate elements of the range requirement. This strategy can balance the demand for local range capabilities with that for stand-alone SUA, which may be an acceptable substitute for training, thus improving the cost-effectiveness of range operations and giving units the operational flexibility they need to meet training requirements.[2] An optimal strategy requires being able to collapse planning time lines,

[1] How they might use this new information about SUA needs to be diagramed and understood.

[2] The standalone SUA referred to here is airspace that may be near, but is not part of, the larger range complex. Under NextGen NAS, it could be created as needed. Both would be scheduled using CSE and reported to FAA flight planning and en route information management systems. Discussions with FAA military liaison personnel, various meetings in Washington, D.C., and Herndon, Virginia, 2008.

gain a regional or even national outlook on range resources, and model different operational approaches and their effects on capacity.

- **Collect range use data.** Range managers and users alike would benefit from detailed data collected from completed training activities. To make this possible, unit scheduling programs need to be able to feed mission information into the range date archive for each sortie, comparing the mission profile scheduled with the mission profile flown. Storing data in a relational database can also help the system respond to FAA's anticipated requirements for machine-to-machine tracking.
- **Define range expectations more clearly.** In response to external pressures, the Air Force must be more deliberate about justifying its range use. Toward that end, range managers need complete information about the purposes of range activities. Using mission profiles linked to joint mission objectives would satisfy that need. Advocates would have descriptive sortie information from mission profiles in CSE. If RAP-based training categories were used, these could be readily linked to the applicable joint mission, as the RAND Decision Tool illustrates.
- **Provide range information that goes beyond the local level**. Users and managers alike would benefit from a broader perspective on range availability and demand. In addition, this broader information perspective can help the Air Force prepare for the transition to NextGen, which will require the Air Force to make more timely data on range operations available to FAA monitoring systems.

Recommendations

The Air Force needs to pursue a strategy for improving airspace and range data processes and incorporating these data into a common enterprise system for Air Force ranges. Several possible steps for pursuing such a strategy center on the use of a common range and airspace scheduling tool:

- **Develop tactically based training templates for use in scheduling.** Units scheduling training can help range managers understand their training needs by using tactically based mission templates that capture the basic requirements of various training sorties. The templates would originate with MAJCOM-level tactics officers, instructors, and training program managers. Training information embedded in the templates can be presented as an authoritative standard for sizing mission profile requirements in CSE. This information includes the airspace and range capabilities required to meet the training objectives and required additional capabilities, such as a radar threat, coordination with a tactical ground element, or aircraft sensors that work with other aircraft in CAS.
- **Make an automated scheduling tool the standard format for range training archives.** Information on completed training activities can be stored in the scheduling tool's database, which will furnish Air Force managers and decisionmakers with detailed information on how ranges are actually being used.
- **Use an automated scheduling tool to standardize the range "market."** The range community can use the tool's information structure to encourage adoption of data standards as a condition of range use. The ability of such a system to share data with other decision tools will benefit decisionmakers at all levels in a variety of ways.

- **Use the tool at higher levels.** A networked scheduling tool system can inform program managers and other decisionmakers about how range use is meeting training needs. The program can create reports that provide information about individual complexes and can also document use across the entire enterprise. Armed with better information, high-level users can become more-effective advocates for ranges. They will also be better prepared to evaluate alternative use proposals and the potential impact on range operations. This offers decisionmakers a more-strategic vantage point from which to craft more informed decisions.
- **Prepare data that are compatible with FAA's planned NextGen system.** The Air Force must also establish an operational-level counterpart to work with the FAA as it implements the NextGen system. Over time, the FAA's new ability to view SUA status and act on what it sees will pressure the Air Force to open up military test and training areas to en route traffic. As NextGen is fielded, some of these tasks will be automated. The FAA expects the military to shift its SUA reporting to machine-to-machine coordination, using CSE to feed data into the FAA flight planning and en route systems. This expectation may need adjustment, however. Those who use this information for flight planning and en route navigation—FAA personnel and pilots—will need to be able to adapt how they use it under normal operations to situations in which unforeseen events that force changes in airspace priorities to mitigate NAS flow problems. Through NextGen, pilots en route will be able to see whether scheduled military aircraft are currently using SUA and, if not, may make more entry requests. But the information from NextGen may not be complete. Making SUA information more visible to NextGen FAA flight planning systems, controller display equipment, and software will improve the ability of controllers and military liaison personnel to defend SUA use against encroachment. For this to work, the data on SUA must be compatible with NextGen equipment and decision processes and help meet NextGen objectives for smoothing traffic flow in the NAS.

The Key Initiative

The challenges surrounding range management arise from the need for better information about range demand, supply, and use and the need for a standardized infrastructure for sharing that information across the range community, users, and other stakeholders. We see implementation of an automated scheduling tool as the key initiative in the Air Force's efforts to address these challenges.

As an automated scheduling tool is implemented, it should help provide a more timely and explicit means for units and MAJCOMs to communicate their demands on range infrastructure. Using the information architecture inherent in the tool should help managers better understand unit use and how that use will evolve in the future under MAJCOM guidance and direction. The tool will provide a standardized transaction structure with an associated database that should make it easier for managers to link training activities to joint missions and national security strategy (Appendix C).

APPENDIX A

Air Force Ranges: Supply and Demand

This appendix catalogs ranges, both Air Force and non–Air Force assets that the Air Force uses, located both inside and outside the continental United States. It also describes the basic training and testing activities that take place at ranges.[1]

Understanding what test or training activities require a range is critical to advocating for and making informed decisions about range investments and OPTEMPO. To meet the demand, ranges must be able not only to the supply the required capabilities but also to scale them as needed for test and training. How the information resource is organized and deployed affects both qualities of the range demand. The organization of that information affects how well the Air Force can advocate for these resources and develop strategies to mitigate potential encroachment from civil air traffic and communities, including energy or other forms of development.

Categorizing the Ranges the Air Force Uses

We identified five types of ranges:

- primary training
- major test
- test and training
- other DoD—Army and Navy
- overseas complexes.

We will describe these types in greater detail in the following sections.

Seldom is any range used exclusively for either test or training. Each MAJCOM with a flying mission will conduct some form of test or evaluation that is not training. Test units will also have training missions to ensure that personnel maintain a high level of proficiency.

There are 44 range complexes that have significant Air Force activity. This number can include a mix of up to 40 air-to-ground and air-to-air range complexes, three space ranges, and two information operations ranges. Of these 44 range complexes, the Air Force owns only

[1] As mentioned earlier in the document, the number of range complexes of interest to the Air Force can vary over time depending on demand and unit tasking. This list is a snapshot for the period of our research. It represents areas of significant Air Force unit use and investment. This organization of the list attempts to focus on predominant use or funding. In some cases, the name reflects this organization; in others, it does not.

18. Two are located overseas. Two are also space launch ranges,[2] which are included in the Air Force test and training range program but have very little utility for Air Force flying activities.

Primary Training Ranges

Primary training ranges support training programs, which can be either formal training courses or continuation-training programs. *Formal training* is part of a course with a standard syllabus that specifically defines what should be accomplished during each sortie. In contrast, *continuation training* provides multiple training options within a general program. Ranges that support formal training courses can and do support the more-general continuation-training sorties combat units require.

Depending on the local user community, the size and mission focus of training ranges can vary. Ranges that support formal courses can require a rather extensive complex of tactical maneuver and ground environments. Those supporting combat units generally require less-extensive range complexes. The typical training range has a relatively small restricted area, relying on maneuvering airspace (e.g., MOAs, low-level training routes) to meet the daily demand for continuation-training program sorties. As a consequence, training ranges not associated with a formal course requirement will rely more on maneuvering SUA than on restricted areas.

Table A.1 provides a brief overview of the primary training ranges the Air Force uses.

Test Ranges

The Air Force has four range complexes configured to support test missions almost exclusively (this includes the two space launch ranges AFSPC controls). These ranges are designed to meet requirements for aircraft, space, and weapon acquisition programs or operational testing. They not only must sustain the range's abilities to monitor and assess testing and performance

Table A.1
Air Force Primary Training Ranges

Range	Location	Acreage	Operator
Dare County	Seymour Johnson AFB, North Carolina	46,684	ACC
Avon Park	MacDill AFB, Florida	406,110	ACC
Claiborne	Ft. Polk, Louisiana	3,140	AFRC
Goldwater East	Luke AFB, Arizona	1,600,000	AETC
Grand Bay	Moody AFB, Georgia	5,900	ACC
Hardwood	Volk Field, Wisconsin	7,929	ANG
Jupiter Butte Annex	Mountain Home AFB, Idaho	12,812	ACC
Melrose	Cannon AFB, New Mexico	66,033	AFSOC
Poinsett	Shaw AFB, South Carolina	12,500	ACC
Saylor Creek	Mountain Home AFB, Idaho	109,000	ACC
Smoky Hill	Ft. Riley, Kansas	33,000	ANG
Warren Grove	New Jersey	9,416	ANG

SOURCE: AF/A3/5.

[2] The Space Test and Training Range provides a safe and secure means of accomplishing test and training activities with space assets. This range can be used to integrate a space capability with aircraft and ground forces. It does not have the airspace or ground environment requirements that aircraft require. Discussions with AFSPC/A3 personnel, May 2008.

but also must be able to accommodate niche test program requirements as new systems are introduced.

Like range complexes associated with formal training, test ranges evolve over time. An example of this would be the range improvements associated with fifth-generation fighter aircraft, such as the F-22 or F-35. These programs have specific requirements tied to acquisition milestones. Another example is the air-to-air range part of the Eglin complex that supports Tyndall AFB activities that involve actual live missile engagements with target drones. Training is certainly conducted at these range complexes, when priorities allow. While there are relatively few such range complexes, they have relatively large restricted areas, primarily for safety but also, in some cases, for operational security. Table A.2 provides specifics on the Air Force's test ranges.

Test and Training Ranges

Few range complexes support both training and testing, which require a mix of restricted and maneuvering airspace. Such ranges also may support tactics development, which can be more dynamic than traditional testing to support an acquisition program. Some testing may support MAJCOM efforts to sustain the combat capabilities of existing major weapon systems, for example, air-to-surface activities with live munitions at the Utah Test and Training Range. Table A.3 provides information about the two Air Force test and training ranges.

Both of the ranges in Table A.3 have significant training missions. Nevada Test and Training Range, for example, may participate in such major large-force exercises (LFEs) as Red Flag, and operational AFSOC units use Eglin AFB, Florida, for continuation and formal training.

Other DoD Ranges

In the list of 43 range complexes of interest to the Air Force, almost two-thirds are not owned or operated by the Air Force. In the continental United States, most of these are Army ranges that are used to help train aircrews and ground personnel in air-to-ground combat tasks. Some of these ranges have limited maneuver airspace and are therefore restricted to one- or two-

Table A.2
Air Force Test Ranges

Range	Location	Acreage	Operator
Cape Canaveral	Patrick AFB, Florida	—	AFSPC
Edwards AFB	Edwards AFB, California	58,080	AFMC
Eglin AFB	Eglin AFB, Florida	463,360	AFMC
Vandenberg AFB	Vandenberg AFB, California	—	AFSPC

SOURCE: AF/A3/5.

Table A.3
Air Force Test and Training Ranges

Range	Location	Acreage	Operator
Nevada Test and Training Range	Nellis AFB, Nevada	2,900,000	ACC
Utah Test and Training Range	Hill AFB, Utah	1,804,399	ACC

SOURCE: AF/A3/5.

ship training sorties or to training focused on procedures rather than tactical maneuvers. The smaller ranges are not certified for actual release of some stand-off munitions and, in some cases, inert training shapes.[3] Table A.4 details ranges other services own that the Air Force uses.

The Army's ranges are increasingly important to deploying Air Force units that require additional training with a ground command and control element. These ranges are also, however, optimized for Army training, so the airspace may not be flexible enough for the more-complex aerial tasks. The adversary threat arrays deployed on the ranges, if any, may not be optimized for Air Force aircraft training.

Overseas Ranges

The United States can access the overseas range complexes of foreign governments by negotiating military-to-military agreements for overseas-based and deploying units. The U.S. Air Force currently uses five overseas ranges (see Table A.5) and may also use others to support annual

Table A.4
Other Service Ranges

Range	Location	Acreage	Operator	Owner
Adirondack	New York	35,000	ANG	Army
Airburst	Ft. Carson, Colorado	3,110	ANG	Army
Atterbury	Camp Atterbury, Indiana	33,000	ANG	Army
Blair Lakes	Ft. Wainwright, Alaska	2,560	PACAF	Army
Bollen	Ft. Indiantown Gap, Pennsylvania	18,000	ANG	Army
Cannon	Ft. Leonard Wood, Missouri	4,405	ANG	Army
Centennial	New Mexico	107,520	ACC	Army
Falcon	Ft. Still, Oklahoma	5,200	AFRC	Army
Grayling	Camp Grayling, MI	8,000	ANG	Army
Jefferson	Indiana	55,280	ANG	Army
McGregor	Holloman AFB, New Mexico	10,000	ACC	Army
McMullen	Texas	1,200	ANG	Navy
Oklahoma	Eielson AFB, Alaska	51,200	PACAF	Army
Oscura	Holloman AFB, New Mexico	57,120	ACC	Army
Razorback	Ft. Chaffe, Arkansas	19,670	ANG	Army
Red Rio	Holloman AFB, New Mexico	55,680	ACC	Army
Shelby	Mississippi	26,676	ANG	Army
Shoal Creek	Ft. Hood, Texas	17,540	AFRC	Army
Townsend	Georgia	5,183	ANG	Marine Corps
Yukon	Eielson AFB, Alaska	51,200	PACAF	Army

SOURCE: AF/A3/5.

[3] The same can be true for smaller Air Force training ranges in the categories above. In all such cases, safety criteria must take into account the angle of approach to the target area, the speed of the aircraft or weapon, the altitude at release, and other criteria related to either the MDS or weapon. For these reasons, air-to-ground ranges may be restricted to one or more types of aircraft or weapon releases. Ranges that limit approaches to narrow access to a target may not be adequate for tactical maneuvering involving multiple, or even a single, aircraft. Discussions with ACC/A3 personnel, November 2007 and January 2008.

Table A.5
Overseas Ranges

Range	Location	Operator	Owner
Dragon	Misawa AB, Japan	PACAF	Japan
Pilsung	Osan AB, Korea	PACAF	Republic of Korea
Polygone	Ramstein AB, Germany	USAFE	USAFE
Siegenburg	Ramstein AB, Germany	USAFE	USAFE
Torishima	Okinawa AB, Japan	PACAF	Japan

SOURCE: AF/A3/5.

allied or coalition training exercises. The two overseas MAJCOMs—USAFE and PACAF—use exercise funds for periodic access to a wider number of ranges to support theater engagement and for training deploying aircrews from the active and reserve components. Rather than performing day-to-day range management, a range manager for a MAJCOM who serves at an overseas location focuses on gaining access for units assigned overseas and on helping deploying units become familiar with working with other national forces.[4] A major portion of these tasks involves working directly with allied and host-nation Air Force personnel to create exercise training events.

The use of overseas ranges can be hampered by a number of problems not prevalent at U.S. range complexes. Foreign ranges may have limited SUA because military training has a lower priority than civilian air traffic locally. Range complexes can be relatively small, and U.S. forces must share the available capacity with the host nation and with other services. Investments in range systems for tracking aircraft or scoring and training feedback may also be more difficult to coordinate with host governments. Resolving these issues favorably requires an engaged and informed manager working assertively with his foreign military counterpart.

Demand for Range and Airspace

Air Force range and airspace requirements are driven primarily by two activities. The first is test and evaluation. Testing informs and validates military equipment and aircrew TTP. Testing requires an environment in which the activity can be safely conducted even when potential test outcomes are in doubt. The test program responds to the objectives necessary to reach the DOC of the target aircraft, system, or weapon. Each specific test is designed to support either demonstration of a capability or determination of prudent operational limitations and procedures; it also helps validate the sustained capabilities of a weapon system through test missions using operational scenarios.

The second activity is training, which creates, focuses, and sustains combat power. Objectively focused on a unit's DOC and its expected military operations,[5] training can be either

[4] Discussions with USAFE and PACAF range managers and operations personnel, May and June 2008.

[5] The desired capability here is rarely more specific than a general statement, such as "general purpose" for fighters with an air-to-air and a strike role within their MDS functionality. It can be broken out further, such as "suppression of enemy air defenses" when the MDS has a special mission capability, but for the bulk of the force, the DOC is relatively general and is aligned with the MDS assigned to the unit. To understand the DOC from a unit training requirement, it is necessary to understand what aircraft are assigned to at least the block configuration of the aircraft and weapons expected to be used

formal or *continuation*. Just as in testing, training also responds objectively to a desire for an operational capability. Training, however, focuses on integrating the personnel with the technology and operational practices. Training requirements can be very specific, such as those for a formal qualification course, or more general, as in a program focused on sustaining a combat DOC over a specific period.

Continuation training essentially provides commanders with a set amount of resources to sustain their combat capabilities within readiness thresholds according to the stage of the AEF deployment cycle. Units are also expected to season their personnel with opportunities to deepen their experience and improve their tactical judgment in operating the assigned weapon system. Continuation training is therefore subject to evolving requirements that may go beyond those in MAJCOM training directives. Continuation training thus focuses and sustains the combat power that formal courses and qualification training create. In wartime, continuation training can evolve rapidly in directions that are hard to predict.

Training also requires a safe environment that will ensure that military training requirements can be met without endangering civilian air traffic or nearby civilian populations.

The following sections examine the Air Force's use of ranges and airspace for both test and training activities in more detail.

Test and Evaluation Activities

Each MAJCOM conducts some test and evaluation to support its missions. However, AFMC is charged with sustaining the test environment and conducts most research and development testing for acquisition and sustainment programs.

Testing on ranges and their airspace can support research and development, acquisition, and weapon system modernization. For example, new aircraft and weapons, such as the F-35, must be flown within controlled environments to determine whether they meet designed performance parameters and display the expected behavior.

Test and evaluation activities also validate combat capabilities by evaluating weapon system sustainment through extended operational test and evaluation. This also helps the Air Force understand how systems age and develop mitigating strategies intended to sustain or extend a specific capability.

A test or program director's objectives for a specific test may require specialized range capabilities and the associated range environment, and ranges should be able to keep accurate records of such requirements. Generally, ranges and SUA airspace require additional monitoring and communication capabilities to record the technical details of such flights. A specific test program might require special environments, such as the ability to isolate sensors and electronic emitters from interference from other potential emitters. For example, this capability is needed to test an aircraft's electronic countermeasures.

Test and evaluation range activities are also conducted to fine-tune TTP and address safety concerns. For example, one activity helped produce new tactics to deliver munitions into caves in mountainous terrain. Test and evaluation has also helped improve the Air Force's understanding of how to fight in urban environments while troops are engaged in combat.

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during deployment. MAJCOM training documentation is organized around the specific MDS and block configuration, where applicable.

Relatively long time lines are required to plan and execute test and evaluation range activities to allow sufficient time to program, budget, and execute required range improvements. The activity for each sortie is generally well-defined, with clear performance objectives. Planning is deliberate, with explicit thresholds for the desired test environment, system monitoring, and support (aircraft and ground systems).

Test and evaluation range activities are funded through a variety of acquisition, research, and development programs, with each activity being accounted for and charged against the program it supports. Almost two-thirds of the test and training program budget is allocated to test requirements.

In general, a given test activity generally is directly tied to some fiscal authority and investment requirement for a particular program. However, the activity may be resourced by contingency funding, as in the case of test support for near-term OIF and OEF tactical problems, that is almost always objective, having clear thresholds for success.

Large, remote locations are becoming relatively difficult to sustain, given encroachment from sprawl and increased air traffic. More work needs to be done to identify existing range qualities that may be at risk that make it possible to conduct the most sensitive activities in a safe and secure environment.

Some test activities, though rarely performed, are essential for advanced research or operational readiness requirements. It is not enough merely to count the number of sorties that use a capability. A qualitative measure for that capability must be balanced against the cost of sustaining the capability. It is also, however, difficult to project how important a given capability will be at some point in the future. The Air Force needs a better understanding of what makes these assets essential to sustaining combat capability and mission confidence as threats and joint missions evolve.[6]

Formal Training: Creating Combat Capabilities

Ranging from a few days to more than a year, formal Air Force training enables pilots and aircrews to achieve basic qualification in an aircraft and adds higher-level qualifications as aircrew experience and judgment mature. Formal courses almost always require work in the classroom, simulator, and air, and the air element requires ranges and airspace infrastructures for training missions. Formal courses also produce instructors, test pilots, and mission support aircrew.

Formal courses are shaped by expectations about an entry-level student's ability and the desired level of competency at graduation. For Air Force aircrew trainees, formal training can be broken down into very specific sorties, each with a training objective.

Although each MAJCOM provides formal courses to support and sustain its mission, AETC focuses primarily on formal courses, especially initial qualification. Such initial qualification courses respond to operational demands and may contain parallel tracks for personnel who will be assigned to units with different equipment or specialized missions.

[6] Higher-level training capabilities might also fit into this category.

Formal courses require extensive, detailed, and deliberate planning to balance actual flying hours with academic instruction, part-task trainers,[7] and simulators. Each type of instruction offers key strengths that the course director can use to achieve the objective level of competency for a variety of students. Courses rely on an experienced instructor cadre that operates within the parameters of a structured environment.

Much like testing, formal courses are planned in detail, with each sortie intended to meet a specific objective and training outcome. These objectives are well understood and rarely change. Training programs are set months in advance as AETC, 19th Air Force,[8] and client MAJCOMs work together to determine course materials, training objectives, and training time available and to address other considerations.[9]

Ranges and airspace are essential for many formal courses. For example, many fighter training sorties require threshold support on the training range and/or SUA (both aircraft and ground systems). Range feedback systems can be important for any training the objective information they provide reinforces the flight experience, making them qualitatively valuable for formal instruction flights. Finally, range managers adapt the range's capabilities to the formal training objectives expressed in the training planning process.

Continuation Training: Sustaining Combat Capability

Continuation training helps aircrews sustain and deepen the tactical and platform knowledge they need be combat ready for overseas deployments supporting AEF operations. In contrast to formal training, continuation training works to sustain mission qualification. It must also provide an opportunity to mature the experience level of the unit's personnel and do so with organic flight leaders and instructors.

Flying units work within a DOC based on a general operational category. The unit is assigned aircraft acquired and configured for its DOC, but it may possess specialized equipment or a weapon capability for a more-specific combat or support task.

Air Force continuation training would not be possible without adequate access to ranges and airspace. Training flights using ranges and SUA both reinforce lessons learned during formal instruction and deepen aircrew experience in the process of conveying tacit knowledge about tactical maneuver in a threat environment. Realistic flying environments with threats, vertically developed targets, and larger range areas that accommodate multiple aircraft provide a richer flying experience, especially if linked with range feedback systems, such as those that provide information on aircraft position and those that record how aircrews maneuver to hit targets. The opportunity to fly regularly in realistic range environments can be important for seasoning aircrew judgment and skill proficiency. Existing training directives understate the need for such seasoning, although it clearly is important to commanders with deploying units.

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[7] A part-task trainer is a training device aimed at a specific flying task, such as air refueling. It generally has less fidelity to the aircraft than a simulator does. The device will work only within the narrow context of the objective training.

[8] One of two AETC's NAFs, 19th Air Force, concentrates on planning and executing formal flight training courses. (In the future, when 19th Air Force is inactivated, AETC will conduct these tasks.)

[9] Each MAJCOM conducts some formal flight training courses in support of its mission. However, the objective is for AETC to conduct initial qualification training for a weapon system. Discussions with AETC, ACC, USAFE, PACAF, AFSOC, and AMC training program managers, November 2007–June 2008.

For example, exercises with a vertical development target (e.g., urban environment) may help aircrews develop a tactical sense of where to direct sensors or how to maintain contact with friendly forces—key skills for some deployment tasks commanders may expect.

RAP has become the term of choice for MAJCOM continuation-training programs. The concept originated at ACC in the late 1990s as training program managers attempted to consolidate currency and weapon events into sorties planned for and executed under a training scenario. For example, a RAP SAT requirement calls for demonstrating a threshold level of tactical maneuver rather than basic air-to-ground procedures. SAT-CAS requires an even higher level of situational awareness and tactical maneuver that is more complex to schedule and requires a ground or air control element on the range. A basic fighter maneuver (BFM) sortie focuses on the basic skills for an air-to-air DOC but also builds fundamental aircraft-handling skills for air-to-ground activities.

Other Factors That Affect Demand

Training Windows at Available Ranges

Because preparing for an upcoming deployment requires access one or more ranges, unit commanders must ensure that they are ready to take advantage of available training schedule windows. The windows themselves are bound by such factors as

- the length of daytime and/or nighttime available for training
- climate or weather conditions
- the unit's priority relative to other range users
- the range's operations and maintenance tempo.

Daytime and Nighttime

Since ranges are geographically fixed, they have a finite but predictable amount of daylight or darkness available on any given day. In scheduling a given range, commanders must take into account the day-or-night conditions the training requires. For example, for safety reasons, some exercises must take place only in daylight. Other sorties require darkness to renew specific, perishable pilot skills. Some training activities (e.g., the use of night-vision goggles) require sensor operations during nighttime conditions.

Weather

Weather affects individual sorties randomly, but its longer-term effects on range availability can be expressed in terms of a percentage of available flying days. Units thus plan for a certain number of sorties with the understanding that a given percentage of them will have to be cancelled or will be ineffective because of weather conditions at the time. To be prudent, unit commanders may adjust their training tempos to account for seasonable weather conditions that may restrict range access. For example, seasonal coastal fogs are regular enough in certain areas to affect early morning and early evening training schedules.

Unit Priority Level

The priority a unit has for range use is a significant factor for the commander's planning. That priority is generally set by an authority higher than the range manager.

A unit commander saddled with a low priority has several ways to overcome the challenge, particularly when the issue is with the local range. One option is to seek a more-reliable range training window, even if that means traveling some distance from home base. Another is to coordinate the more-complex training events with larger service or multiservice exercises, thereby gaining the priority of the exercise. For example, the CAF RAP now routinely incorporates Red Flag exercises, which then serve as major force and small-group "graduation" training exercises just prior to unit deployments.

When the Air Force does not own and operate the range in question, commanders must work carefully with the relevant service or foreign government to gain the access they need. In these cases, the Air Force unit's priority may be a function of interaction with units from other services, offering training to all. For example, for access to Fort Polk, training sorties must include a certain amount of Army ground force participation, even if the participating Air Force units do not require the additional SAT-CAS sorties.

Range Operations and Maintenance Tempo

The influence on a range training is the range manager's approach to operations and maintenance. If a commander makes the unit's requirements clearer to the range manager early enough in the range scheduling process, the range manager will have time to adjust range operations as necessary to accommodate additional capabilities.

However, in reality, most commanders see range operations and maintenance tempo as a given to which they must adapt, partly because the drivers of range operations are fiscal and contractual arrangements, not a single unit's AEF training cycle. Even if the units can present timely information to the range manager, the unit commander's choices may be constrained by range contracts or by the needs of units with higher range priorities.

In some cases, range operations managers have hired civilian contractors. While these contracts may include options for adding to or adjusting range operations, they can also set thresholds for these options that require either more notice or more funding. As a result, units that can communicate their requirements earlier—such as test or formal training units—may give the range manager additional time to plan around and mitigate any contractual constraints.

APPENDIX B

Updated Decision Support Tool

Background

In the late 1990s, RAND conducted research for ACC that established a process for linking infrastructure requirements to training requirements and, in turn, to operational requirements that demonstrably serve national security interests. A significant element of this work involved collecting, organizing, and relating objective information about the demand for training. One product of this research was a database relating ranges and airspace to ACC continuation-training activities listed in training documents (see Robbert et al., 2001a, and Robbert et al., 2001b). The updated version of this database is provided on the CD included with this report.

The decision tool itself focused on the supply and demand information needed for managing MAJCOM ranges and was to be a web-based system with a common graphical user interface. Data owners would supply and update information that would be available to a wide range of stakeholders, including mission schedulers and planners, range controllers and managers, and offices tasked with monitoring use and environmental cleanup.

Figure B.1 illustrates the tool. The box in the upper left represents RAND's joint mission framework, which outlines joint missions, their operational objectives, and the associated operational tasks.[1] The decision tool linked commanders' DOC statements for joint missions to the training requirements described in ACC RAP sorties. As the figure shows, the tool develops event details for RAP sorties (such as mission profiles, support requirements, sortie frequencies, time required per sortie) and explicitly links these events to sets of range and airspace qualities (maneuver area size, target type, threats, etc.).[2] As the arrow at the bottom of the figure indicates, the tool then compares the infrastructure requirements with the current infrastructure. The result is a linkage from the DOC, through the training requirements, to the available ranges.

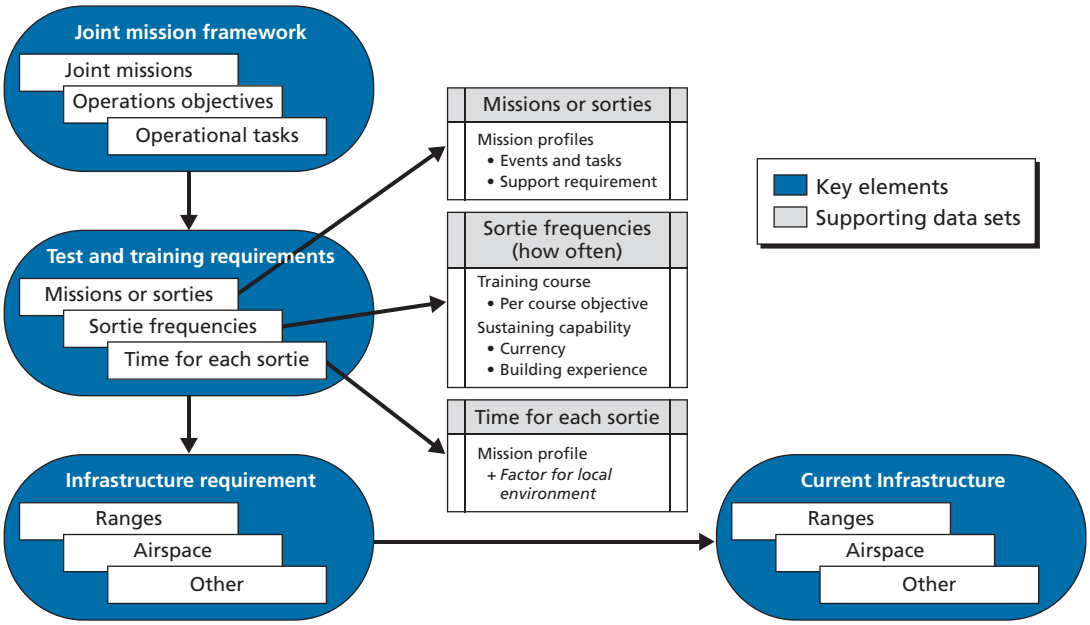
Tables B.1 and B.2 illustrate the detailed information underlying the tool framework. Table B.1 is a partial list of training requirements developed.

For example, the first row shows air combat maneuvering (ACM) as a training requirement and lists RAP documents as the source of information regarding the individual events

[1] A joint mission framework is an objective series of statements that represents the demands CCDRs make on forces. The statements are blind to the means of meeting the stated objectives. They are more-general and strategic than the Unified Joint Task List or the Joint Mission-Essential Task List, which are not Air Force documents. While the framework can be mapped onto specific lists of either type, the goal is to provide the Air Force a product designed for flying operations.

[2] The required qualities RAND used were informed by extensive interviews with unit instructors, weapon school instructors, and ACC training program managers.

Figure B.1
Elements of the Original Range and Airspace Decision Tool



SOURCES: Robbert et al., 2001a, and Robbert et al., 2001b.
NOTES: Elements relate to each other in an analytic structure that maps operational missions, objectives, and tasks to training requirements onto a one-to-many relational database framework. Key elements must follow in series. Infrastructure requirements (demand) and current infrastructure (supply) must be linked in a way that permits a comparison.
RAND *TR874-B.1*

related to that training category. Table B.2 shows how training requirements are linked to range requirements in the tool.

The first column of Table B.2 describes range attributes. The first row specifies that the minimum length required of restricted airspace for an ACM sortie is 30 nautical miles. As another example, the row labeled "strafable targets" has an "X" in the "CAS Day/Night" column. This means that a CAS mission requires the range to have targets that can be strafed.

Figure B.2 is a screen shot that shows how the tool combines information for the user. Here, the user has indicated the desire to train in a BSA/Day sortie at a range at Eielson AFB. The tool determines the range requirements for the sortie and compares the requirements (which the user has indicated by checking boxes under "Required" at lower right) for the sortie to their availability (under "Available"). Some of the latter group of boxes are not checked, indicating that these requirements are not available. Thus, this range would not be suitable for the requested mission.

At the time RAND first developed the decision tool (2001), the Air Force did not have web-based or automated methods for collecting and maintaining information about range capability from local managers. Range and airspace transactions were unique to the local range or airspace authority and the local user base. A broader ownership of the tactics, training, and joint planning and priorities data sets was needed. In the research context, a web-based relational database would hold together different data owners and would improve understanding of the decision environment beyond what any one program could provide.

Table B.1
Aircrew Training Requirements

Training Requirement	Abbreviation	Training Category	Source
Air Combat Maneuvering	ACM	ACM	RAP Documents
Air Combat Maneuvering	ACM (A-10)	ACM (A-10)	RAP Documents
Air Combat Tactics	ACT	ACT	RAP Documents
Aircraft Handling Characteristics	AHC	AHC	RAP Documents
Air Strike Control	ASC	SAT	RAP Documents
Basic Fighter Maneuvers/Maneuvering	BFM	BFM	RAP Documents
Basic Fighter Maneuvers/Maneuvering	BFM (A-10)	BFM (A-10)	RAP Documents
Basic Surface Attack - Day	BSA Day	BSA	RAP Documents
Basic Surface Attack - Day	BSA Day (A-10)	BSA (A-10)	RAP Documents
Basic Surface Attack - Night	BSA Night	BSA	RAP Documents
Basic Surface Attack - Night	BSA Night (A-10)	BSA (A-10)	RAP Documents
Close Air Support	CAS (day/night)	SAT_CAS	RAP Documents
Close Air Support - Day	CAS Day	SAT_CAS	RAP Documents
Close Air Support - Night	CAS Night	SAT_CAS	RAP Documents
Combat Mission Section	CMS	ACT/SAT	RAP Documents
Conventional Training	ConvTng	SAT	RAP Documents
Commander Option	CC Option	AEF_Prep	RAP Documents
Defensive Counter Air	DCA	TI/ACT	RAP Documents
Defensive Counter Air - Night	DCA Night	TI/ACT	RAP Documents
Element Threat Reaction	ETR	ACM_ETR	F-15E Syllabus
Forward Air Controller (Airborne) - Day	FAC(A) Day	SAT	RAP Documents
Forward Air Controller (Airborne) - Night	FAC(A) Night	SAT	RAP Documents
Global Strike	SAT_GS	SAT	RAP Documents (F-22)
BSA_High Altitude	BSA_HA	BSA	RAP Documents (B-1)
Intercepts	Intercepts	TI	RAP Documents
Intercepts Night	Intercepts Night	TI	RAP Documents
Instrument Training	Instrument	Gen	RAP Documents
Instrument SIM	Instrument SIM	Gen	RAP Documents (F-15)
Joint-Supression of Enemy Air Defenses	J-SEAD	SAT_SEAD	RAP Documents (F-16)
Large Force Engagement	JOINT/ COMPOSITE	LFE	RAP Documents (B-1)
Low Altitude (Bomber)	LA	Gen	RAP Documents (B-1)
Low Altitude Step-Down Training (Air-to-Air)	BFM_LA	BFM	F-15E & F-16 Syllabi
Night Systems Basic Procedures (F-16, OA-10)	Night Systems (F-16, OA-10)	BSA (F-16, OA-10)	Syllabus
Nuclear Systems Training mission	Nuclear Trng	BSA	RAP Documents
Offensive Counter Air	OCA	ACT	RAP Documents
Offensive Counter Air - Air-to-Air	OCA-A	ACT	RAP Documents
Offensive Counter Air - Sweep	OCA-Sweep	ACT	RAP Documents
Offensive Counter Air - Escort	OCA-Escort	ACT	RAP Documents
Offensive Counter Air - DEAD	OCA-Dead	ACT	RAP Documents
Offensive Counter Air with Surface Attack	OCA-SAT	ACT/SAT	RAP Documents
Red Air	Red Air	Gen	RAP Documents
Surface Attack Tactics	SAT (day/night)	SAT	RAP Documents
Surface Attack Tactics - Day	SAT Day	SAT	RAP Documents
Surface Attack Tactics - Night	SAT Night	SAT	RAP Documents
Suppression of Enemy Air Defenses - Night	SEAD/DEAD (night)	SAT	RAP Documents
2-Ship SEAD/DEAD	2-Ship SEAD/DEAD	ACM_SEAD	RAP Documents
4-Ship SEAD/DEAD	4-Ship SEAD/DEAD	ACM_SEAD	RAP Documents
Tactical Intercepts	Tactical Intercepts	TI	Syllabus
Transition to Landing Instrument Training	Transition	Gen	Syllabus
Transition to Landing Night Instrument Training	Transition Night	Gen	Syllabus
Air Deliverly of Cargo/Personnel	Airdrops	AirLand	Vol I
Air Deliverly of Cargo/Personnel using Night Vision Goggles	Airdrops_NVG	AirLand	Vol I
Aerial Refueling	AR	Gen/AR	Vol I
Aerial Refueling _night	AR_N	Gen/AR	Vol I
Aerial Refueling as Receiver	AR_R	Gen/AR	Vol I
Aerial Refueling as Receiver during Night	AR_RN	Gen/AR	Vol I
Special Operations Aerial Refueling	SOAR	Gen/AR	Vol I
Guided Weapon Training Sortie (B-1)	GWTS	SAT	RAP
Joint Air-to-Surface Standoff Missle Employment Sortie (B-1)	JASSM	SAT	RAP
Combat Skills Sortie (B-1)	CSS (B-1)	SAT	RAP
Combat Skills Sortie (HC-130)	CSS (HC-130)	Gen/AR	RAP

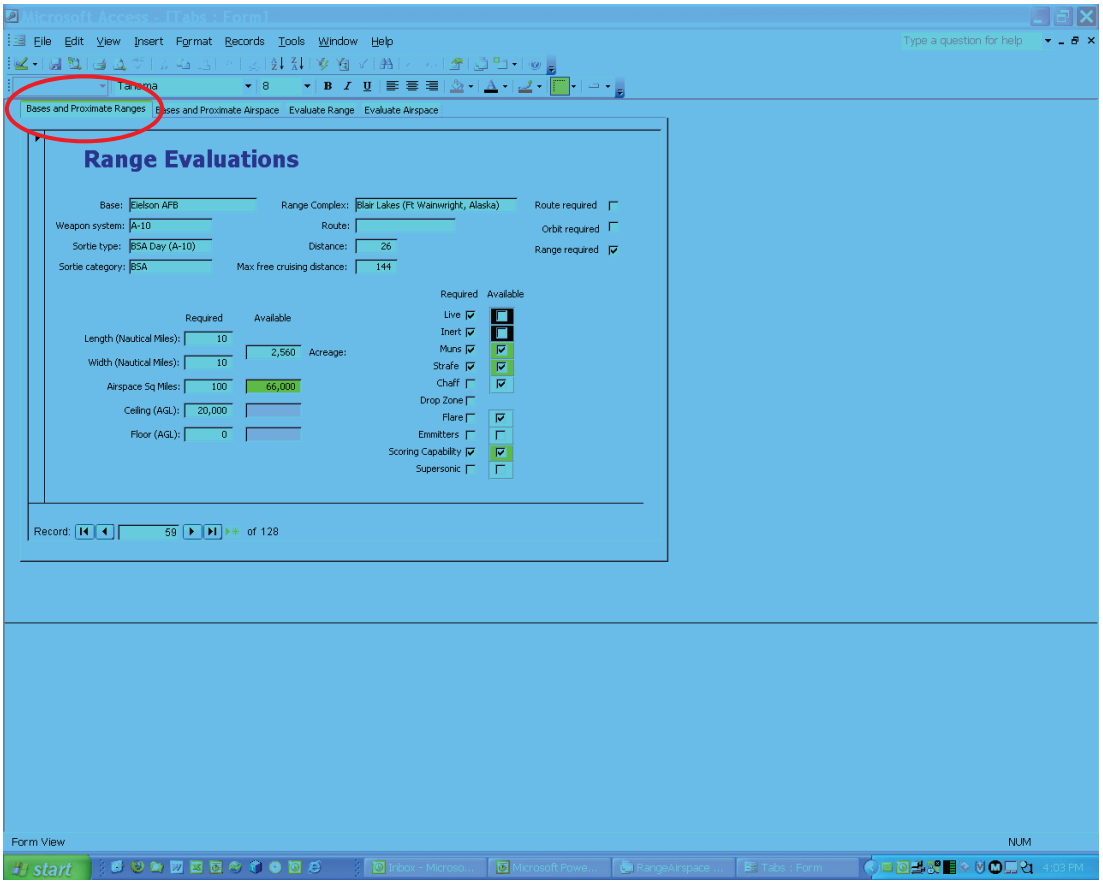
Implementation Overtaken by Events

Changing priorities in the aftermath of the attacks on the World Trade Center and Pentagon led us and the Air Force to set the decision tool aside pending better understanding of the new

Table B.2
Sample Training Categories with Range Requirements

Range Attributes	ACM	ACM (A-10)	ACT	BFM	BFM (A-10)	BSA Day/Night	BSA Day/Night (A-10)	CAS Day/Night	SAT	Tactical Intercepts
Restricted airspace (minimum length (nm)	30	15	60	15	10	15	10	80	80	50
Restricted airspace (minimum width (nm)	30	10	40	15	10	15	10	50	50	30
Restricted airspace (minimum sq. nm)	900	150	2400	225	100	225	100	4000	4000	1500
Restricted ground area (minimum length (nm)										
Restricted ground area (minimum width (nm)										
Ceiling (AGL)	30,000	20,000	40,000	35,000	20,000	25000	20,000	50,000	50,000	40,000
Floor (AGL)	0	0	5,000	5,000	0	5,000	0	0	0	5,000
Live ordnance capable						X	X	X		
Inert ordnance capable						X	X	X		
Munition capable						X	X	X		
Strafable targets						X	X	X		
Lighted targets										
Laser capable targets										
Chaff								X		
Drop Zone										
Illumination flares								X		
Emmitters										
Refueling SUA									X	
Scoring Capability						X	X	X		
Scoring (Acoustic)										
Scoring (JAWSS)										
Scoring (LSTSS)										
Scoring (M2)										
Scoring (TOSS)										
Scoring (Visual)										
Scoring (WISS)										
Supersonic	X									

Figure B.2
RAND Tool Screen Shot



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operational environment and its effects on operational requirements.[3] In its present form, the tool requires better integration with information about range capabilities, although we have updated it for required range activities. The tool continues to illustrate how information organized as a relational database can be used to make informed decisions.

Center Scheduling Enterprise

Since RAND developed the tool in 2001, and perhaps as a consequence of that development, several automated tools for range and airspace managers have appeared. Generally, these grew from the need to schedule and monitor activity on individual ranges and replaced grease boards and paper logbooks with Excel spreadsheets and, in some cases, online forms. This allowed many people to determine what was available to be scheduled.

The next step was to develop programs that computerized the dialog between the unit scheduler and the controlling or owning authority. One of these tools was CSE, a web-based program the 46th Test Wing developed. The program helps mitigate the lack of unit input by

[3] On another visit to ACC, range program managers where able to retrieve the original decision tool from the ACC network server for us. The original 2001-era RAP information was outdated by subsequent training instructions from ACC, and tactics officers also needed to update the templates used to define RAP sorties and training events.

structuring the scheduling dialog, thereby enabling the range manager to manage requests and to document range use.[4]

Variants of CSE are gradually becoming standard across the Air Force. CSE approximates the web-based architecture that the researchers who developed the first RAND Decision Support Tool envisioned.[5] That first tool required periodic updates of range information, training requirements, and the tactic-based range requirements. MAJCOM decisionmakers would benefit from keeping this information online, with updates from range managers and training program managers. The new scheduling program can meet many of these information requirements.

CSE was, however, created for range and airspace managers and scheduling authorities, not MAJCOM and Air Staff program managers and advocates. This may be a strength because the scheduling transaction provides an incentive to keep database contents up to date. MAJCOM and Air Staff program managers and other stakeholders can periodically access the CSE data they need using the program's report function. The report function also provides a means for periodically updating key data sets in the RAND Decision Tool and other analytic tools that should emerge to support range program advocacy.[6] The RAND tool illustrates what can be done using a standard desktop relational database program available on most DoD computers. (This simplicity has been retained in the updated tool discussed in the next section.)

CSE stores detailed information on test sorties, potentially making that information available throughout the enterprise. For example, the test community can use mission recap to obtain complete information on a test cycle. Similarly, the history in the system provides precedents schedulers can use to determine sortie requirements by using previous mission profiles as templates. As Figure B.3 illustrates, a given sortie requires various range and airspace components, which might ordinarily require schedulers to coordinate among several providers. Through templating, CSE can allow a central transaction for scheduling—as well as central view of the mission profiles of all scheduled sorties.

As an example, a SAT sortie might require a low-level navigation leg, a maneuver area, and a ground environment with appropriate targets and the ability to release a weapon. This would require several range and airspace components, such as low-level routes, a MOA for maneuvering, and a restricted area for the air-to-ground weapon release, along with the requisite targets. One or more of these components would contain threat arrays.

CSE also standardizes the range scheduling transaction. While each range-and-airspace configuration is unique, the process and the information each party requires are the same across the enterprise. CSE also uses a mission profile,[7] which can be used to create a template for RAP sorties from a tactical and training objective perspective. Using this template, tactics

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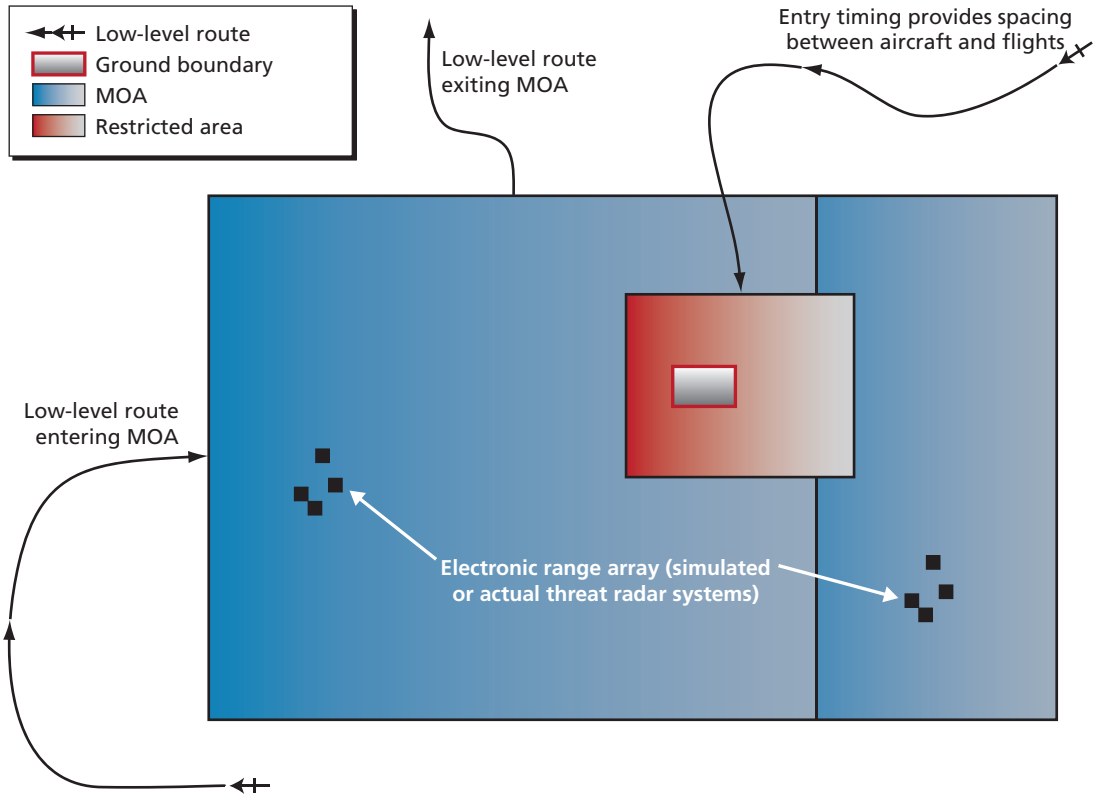
[4] See footnote 4 in Chapter Four for the history of CSE.

[5] The Tybrin Corporation, working with the 46 TW at Eglin AFB, developed CSE. Discussion with Tybrin and 46 TW personnel, November 2008. The 46 TW and Tybrin used findings from our original 2001 work in creating the web-based program. Beyond the tool, that 2001 work called for managing range information through web-based forms. The range manager would use these to input his own information to the database, making it accessible to units and major command program managers for planning. The decision tool RAND created in 2001 (and has updated here) was a smaller element of the broader policy implications.

[6] One example would be ATAC Corporation's base/range loading simulation.

[7] A CSE mission profile collects various range and airspace components for each sortie being scheduled.

Figure B.3
Various Range and Airspace Components of a Sortie Mission Profile



NOTE: The sortie's mission profile would include *all* required SUAs. For example, it would include a low-level entry, a MOA for maneuvering around threats, a restricted area for delivering air-to-ground munitions, and a MOA or low-level route for exiting the area and returning to the airfield.

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officers can work with training program managers to define an objective set of range capabilities necessary for the sortie.

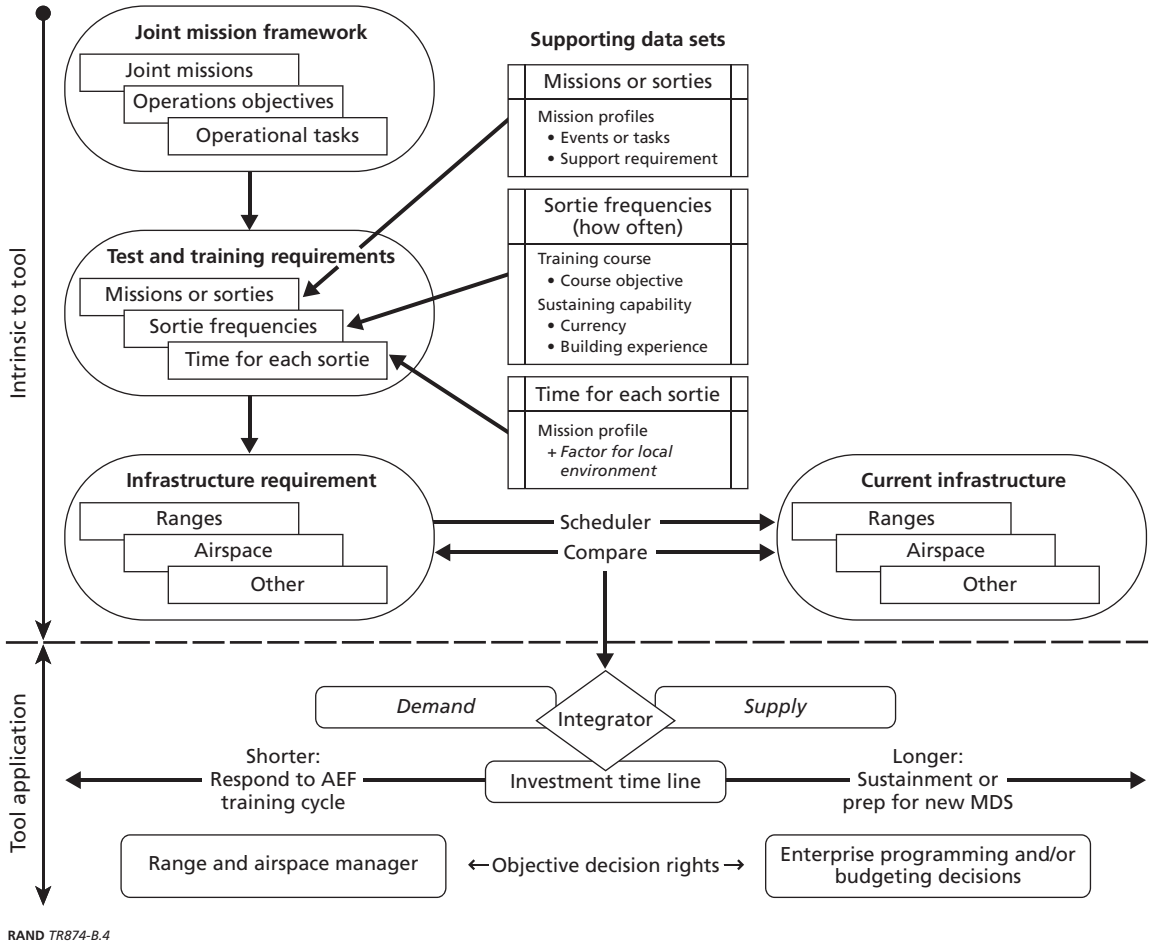
Updates to the RAND Decision Support Tool

Tool Framework

In FY 2008, the Air Force asked RAND to update its 2001 decision support tool for range and airspace operations. Our update takes advantage of developments that have occurred since 2001, such as leveraging CSE's capabilities, but retains all the tool's original features. One example of how the tool now leverages CSE's capabilities is that the user need not directly populate the decision tool with information on what is available on the ranges because CSE automatically supplies this information.

Figure B.4 illustrates the revised framework. The top portion of the figure captures the basic characteristics of the original tool. This area benefits from CSE assistance with data collection and maintenance in each domain and, potentially, across the enterprise. The CSE data library and transactions would be common to all ranges. Users would create CSE mission

Figure B.4
Elements of Reconfigured Range and Airspace Decision Tool



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profiles to communicate their requirements (demand) to the schedulers and resource managers (supply). CSE could harvest a significant amount of demand, requirements, and actual use data from users. The RAND Decision Support Tool was reconfigured to illustrate how a decision tool would operate in the budding CSE environment. The CSE program and the management of the data it creates provide a better information environment for such tools as RAND's to improve tracking requirements and inform planning processes.

The lower half of Figure B.4 represents the manager's job as an integrator of supply and demand. Fundamentally, the support tool compares supply and demand, but how managers and planners apply the resulting information will depend on such factors such as their vantage points and decision time lines. Local managers and planners can also use the tool to search for sufficient capacity to meet their unit needs. MAJCOM program managers could create CSE mission profiles that are like RAND's sortie templates, use the profiles to aggregate training requirements, and evaluate capacity across ranges to make budget decisions.

Training Requirements in the New Tool

As Table B.1 illustrated, the original decision tool included standard range and airspace requirement tables for similar ACC continuous training sorties and events. Although the train-

ing environment has evolved with new tactics and technology, the basic taxonomy remains fundamentally the same. New fifth-generation fighter aircraft, only on the horizon a decade ago, are now being fielded with operational units. Legacy aircraft have acquired new, more-precise weapons requiring new tactics that emphasize working with ISR support and/or tactical ground parties. These activities can still be described within the basic training missions in the original decision tool.

For the updated decision tool, we used the basic templates from the original tool to document training requirements by aircraft MDS. We collected training information from ACC and other commands and incorporated the new or updated data into the appropriate data sets with advice and guidance from MAJCOM MDS staff, USAF Weapons School instructors, and other subject-matter experts.

Although we were able to adapt the earlier template, the training environment has been changing along with combat itself and as commanders see new value in advanced simulators. Embedded training capabilities for fifth-generation fighters and shared airborne constructive tactical environments may enhance tactical training environments. Likewise, ranges have acquired another decade of experience with sortie feedback systems that enhance the training experience. In the past, each MDS operated its own training silo, working with dissimilar strike and supporting aircraft only during Red Flag exercises. Now, each MDS is reaching out to participate in smaller, LFE-like activities, such as CAS and combat search and rescue missions. Another change is the inclusion of such supporting capabilities as aircraft data links and tactical ground parties with control capabilities. Range activities can include working with space and cyber forces in a realistic training context. Mobility air force units are expressing the need to enter range complexes for threat, ground-party insertion, and precision airdrop training. With improving integration of the RAP and the AEF training cycles, the later AEF stages will be more likely to involve multiple MDSs and such supporting elements as contingency airlift, information forces, and tactical teams and may also incorporate constructive and advanced simulator elements.

We also adapted the relationships among data sets to the new military operations environment. This included updating objective statements representing the CCDR's requirements and, when warranted, adding data for new capabilities, such as range threats, target arrays, airborne data link and communications needed given lessons learned from OEF and OIF. We also included data on appropriate linkages to the new Air Force virtual range capabilities for information operations and space mission areas.

Combining CSE and the Updated RAND Decision Tool

CSE is essentially the front end of what the RAND Decision Tool illustrates. The usefulness of the decision tool can continue if tactics officers and training program managers incorporate CSE-shaped mission profiles into training and TTP documentation. They can use the same interview-and-workshop process RAND used or another method that allows expert personnel to create and comment on profiles using a web-based tool, such as a wiki. Again the tactics and training community benefits from CSE standardization. The RAND tool illustrates what can be done using common data sets and a standard relational database program available on many DoD computers.

CSE's archival function for mission data is also helpful for the decision tool. A number of the programs the operations community uses have not been integrated with CSE. Where CSE was in operation for test operations, we found that non-test operational units were using

these other systems or manual processes not automatically tied to CSE. It was not clear how visible user activities at these locations were to the range manager.[8] Certainly, the processes met the requirement for safe operation in the range environment, but the postmission data may not include the specific munitions dropped or the actual use if, for instance, a sortie was curtailed due to weather or maintenance. As a relational database, CSE can theoretically accept information from other programs if it conforms to the data standard and meets data exchange requirements.[9] The enterprise would need this information even if only to track environmental cleanup or other maintenance functions. But it is also needed to effectively articulate the need for range and airspace infrastructure.

In CSE, mission profiles are the primary means of stating a full set of sortie requirements. Currently, whoever creates a profile is the one who updates it. Profiles can serve a broader user community—as templates—especially when indexed within a framework, such as the RAP mission training categories. Some ranges will have a certification process in which the controlling agency reviews mission profiles are reviewed for compliance with range and airspace procedures and/or best practices.[10] To work properly within a broader enterprise information framework, the mission profiles need to be understood to be the current demand.

It is possible, and the decision tool currently supports this, to compare demand with a future supply. This would be useful when considering changes to the range and airspace infrastructure or creating an investment strategy to close on a future desired capability (e.g., an F-35 formal training course). Since the decision tool, like CSE, is essentially a relational database, queries and reports can be structured in such programs as Microsoft Access to answer new questions using one or more of the tool's data sets.

Some of this would require data CSE does not currently include and that would not be created through normal CSE use, thus requiring augmentation from other sources. The data must conform to the CSE's data library and other structural elements. We found that not having access to the CSE structure is a significant technical hurdle for higher-level supply and demand questions, such as those a MAJCOM program manager or the Base Realignment and Closure working group might ask.

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[8] Discussions with subject-matter experts at Eglin AFB and Hurlburt AFB, November 2007 and February 2008.

[9] A study on utilization provided a key finding that "Utilization reports did not provide a complete and accurate assessment of airspace and range utilization" (Air Force Inspection Agency, 2007).

[10] According to test managers at Eglin AFB, where CSE originated, the test director creates a plan that includes the mission profiles needed for the objective activity. These can be fairly complex and are reviewed before being finalized. Profiles for training missions undergo the same review, but the process is generally less formal if the operator works within range parameters. Discussions with 46 TW personnel, November 2007.

APPENDIX C

Joint Mission Framework

The following statements are organized within the RAND Decision Tool and serve as the upper-level requirement for range activities. They are simple, easily understood statements about the desired effects of military forces. These statements are broader than any one service and are unclassified so that they can be used in public venues when advocating for the required range activities.

Deny the enemy the ability to operate ground forces

Halt invading armies

Delay/destroy/disrupt lead units of invading armies
Provide fire support to friendly forces in close contact with enemy ground forces
Delay/damage enemy forces and logistics support in the rear

Destroy/demoralize, and render ineffective armies in the field

Delay/damage enemy forces and logistics support in the rear
Disrupt/destroy enemy forces day and night
Degrade enemy command and control of ground forces

Evict armies from designated areas, occupy terrain as necessary

Degrade enemy command and control of ground forces
Overrun enemy defensive positions
Gain entry into a region
Deny fire support to enemy defenders
Control enemy forces after surrender

Deny the enemy the ability to operate naval forces and maritime assets

Interdict and control naval combatants and maritime traffic

Destroy/disable surface ships at sea or in port
Degrade/confuse shipborne sensors
Disrupt choke points and anchorages
Destroy/disable surfaced submarines
Degrade/confuse submarine sensors

Destroy or deny the use of naval support facilities

Destroy naval command bunkers
Destroy shipborne command posts
Disrupt communications and maritime navigation systems
Destroy ports, logistics facilities, and anchorages

Deny the enemy the ability to operate aerospace forces and other air defense forces

Defeat enemy air attacks

Destroy aircraft in flight
Destroy cruise missiles in flight
Disrupt sensors on enemy aircraft and weapons

Suppress enemy surface-based defenses

Destroy fixed SAM launchers
Destroy mobile SAM launchers and anti-aircraft guns
Destroy tracking and engagement radars

Suppress enemy space-based defenses and offensive capabilities

Destroy/disable ground-based space associated facilities
Destroy/disable space-based space associated facilities

Suppress generation of enemy air sorties

Destroy/damage runways and taxiways
Destroy aircraft in the open or in revetments
Destroy key hardened support facilities
Destroy aircraft in hardened shelters

Degrade enemy command and control of air forces and integrated air defense

Destroy command bunkers and other critical nodes
Destroy mobile command posts
Disrupt communications
Destroy/disrupt airborne command, control, and surveillance platforms
Destroy/disrupt airborne command, control, and surveillance platforms

Counter enemy ballistic missiles

Destroy transporter-erector-launchers (TELs) in the field and disrupt operations
Destroy transporter-erector-launchers (TELs) in garrisons and assembly areas
Destroy fixed tactical ballistic missile launchers
Destroy tactical ballistic missile storage areas

Defeat attacking ballistic missiles

Destroy ballistic missiles in flight (active defense)
Warn friendly forces of attack (passive defense)

Control friendly airspace

Identify and track enemy aerial objects
Deconflict friendly traffic

Control friendly space

Establish warning and surveillance systems
Defend friendly space operations

Deny the enemy the capability to produce, store, or deliver weapons of mass destruction

Destroy facilities producing and storing weapons of mass destruction

Destroy factories and weapons storage sites
Deny access to key sites

Destroy means of delivering weapons of mass destruction

Defeat enemy air attacks
Suppress generation of enemy air sorties
Counter enemy ballistic missiles
Defeat attacking ballistic missiles

Deter the use of opposing weapons of mass destruction

Maintain credible threat of retaliation
Ensure survivability of US nuclear weapons and their control
Ensure US ability to operate in WMD environment

Deny enemy national leaders the means of conducting military operations and controlling their nations

Destroy/disable war-supporting industries and infrastructure

Disrupt national POL production, storage, distribution
Disrupt national power generation and distribution
Disrupt national transportation system
Damage/disrupt enemy's war-supporting industry

Destroy facilities associated with enemy's national and military leadership

Destroy/damage key directing organs and leadership cadres
Destroy leadership and security facilities

Destroy/disable enemy communications networks and control systems

Disrupt/disable key telephone switching centers
Disrupt/disable fixed satellite ground stations
Disrupt/disable space-based satellite stations
Sever landlines
Disrupt/destroy key communications nodes

Deploy and support forces

Deploy forces, support assets, and supplies to theaters of military operations

- Airlift personnel and material into theater of operations
- Conduct aerial refueling
- Sealift personnel and material into theaters of military operations
- Conduct at-sea refueling and replenishment
- Provide navigation, geopositioning, and weather data
- Provide communications support
- Provide reconnaissance, surveillance, command and control and attack assessment products
- Rescue personnel

Deploy forces, support assets, and supplies within theaters of military operations

- Conduct aerial refueling
- Conduct at-sea refueling and replenishment
- Provide navigation, geopositioning, and weather data
- Provide reconnaissance, surveillance, command and control and attack assessment products
- Rescue personnel
- Airlift personnel and material in theater of operations
- Sealift personnel and material in theaters of military operations
- Deploy and redeploy troops within theater

Gain information superiority

Protect Coalition C3ISR Systems

- Establish continuous, fused picture of battlespace
- Protect C3ISR assets from physical attack
- Neutralize enemy C3ISR penetrations
- Deny enemy knowledge of friendly intelligence operations

Degrade Enemy C3ISR

- Degrade enemy picture of battlespace
- Destroy/disrupt enemy C3ISR assets with physical attack
- Penetrate enemy C3ISR systems with cyber attacks
- Gain knowledge of enemy intelligence operations

Establish and defend safe areas

Protect safe areas against external threats

- Rescue personnel
- Destroy/neutralize hostile artillery, mortars
- Deny infiltration
- Disrupt and stop infantry and armor attacks
- Disrupt and stop air attacks/establish “no fly” zones
- Establish positions at key sites nearby safe areas
- Destroy/neutralize key sites

Maintain law and order within safe area

Ensure the enforcement of local laws/regulations
Ensure the dispersal, containment or elimination of crowds
Deter/discourage banditry
Establish/reconstitute local police authorities

Defend safe areas against internal threats

Locate/monitor activities of violent factions
Prevent or eliminate terrorist attacks
Eliminate snipers, particularly in urban terrain
Eliminate SAMs, particularly in urban terrain
Protect key facilities/supplies from sabotage
Reduce/clear mines/minefields

Gain support of local populace

Establish public information/community outreach campaign

Ensure information dissemination
Establish and support community development programs

Ensure provision of essential goods and services

Distribute food and water
Establish medical and dental care
Establish temporary shelters

Gain control of movement across and within borders

Ensure proper flow of goods and personnel across international borders

Find/monitor key illegal supply and infiltration routes
Disrupt transportation of unauthorized goods and confiscate/destroy
Locate and prevent entry of unauthorized personnel

Maintain freedom of movement on key routes

Protect convoys of supplies/personnel in unsecured areas
Reduce/clear mines and remove roadblocks
Protect critical lines of communication and debarkation points

Render humanitarian assistance

Protect delivery of food and medical supplies to distribution points

Protect convoys
Protect relief flights
Protect relief ships
Protect ports of entry, storage areas, and key distribution points

Ensure basic services

Distribute food and water
Establish medical and dental care

Establish temporary shelters

Rescue civilians in distress

Rescue persons in areas of difficult ingress/egress
Rescue persons trapped in collapsed structures
Insure immediate medical attention to the injured

Reconstitute civil authority and infrastructure

Ensure reconstitution of government

Support plebiscites, referenda and/or elections
Support reconstitution of all branches of government
Support reconstitution of judiciary and penal system
Support establishment of local political bodies

Support government provision of needs of its people

Promote public health, safety, welfare, and education services
Ensure food supplies and availability of agriculture components
Promote trade and commerce functions
Promote administration and finance functions

Support repair of key components of national infrastructure

Establish essential transportation infrastructure
Establish/support local defense forces

Ensure the implementation of peace agreement/cease-fire

Separate factions

Deploy US/UN forces in territory between factions
Observe activities/movements of factions
Prevent/neutralize attacks of one faction against another

Ensure disarmament of factions

Seize/destroy illegal weapons caches
Ensure withdrawal/cantonment/destruction of heavy weapons
Deny major movements of arms into and within territory

Support adherence to the agreement

Insure resolutions to implementation disputes at local level
Support the resolution and punishment of violations
Ensure exchanges of POWs, casualties
Support care and repatriation of refugees

Unspecified

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